

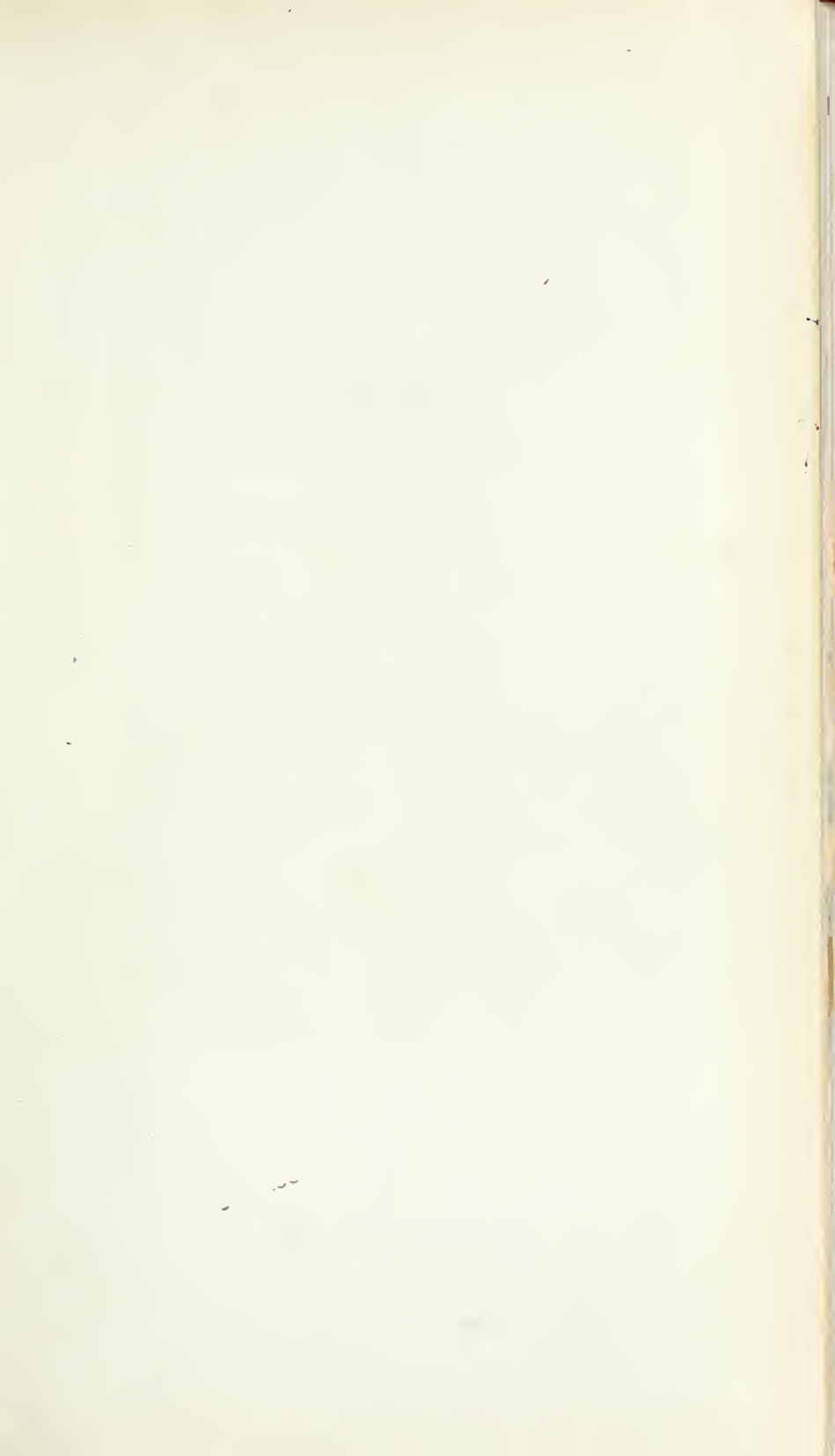
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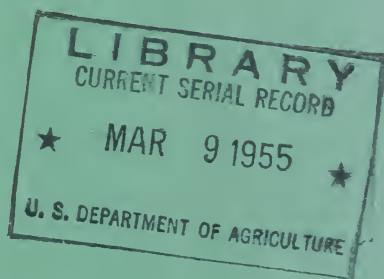
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CROP ROTATION, TILLAGE, AND FERTILITY EXPERIMENTS



at the
LAWTON (OKLA.)
FIELD STATION, 1917-49

Circular No. 951
UNITED STATES DEPARTMENT OF AGRICULTURE

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TILLAGE, AND
FERTILITY
EXPERIMENTS
at the
LAWTON (OKLA.)
FIELD STATION,
1917-49

By W. M. OSBORN, formerly associate agronomist. and
O. R. MATHEWS, senior agronomist, Soil and Water Con-
servation Research Branch, Agricultural Research Service

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II

Crop Rotation, Tillage, and Fertility Experiments at the Lawton (Okla.) Field Station, 1917-49

By W. M. OSBORN, formerly *associate agronomist*, and O. R. MATHEWS, *senior agronomist, Soil and Water Conservation Research Branch, Agricultural Research Service*

INTRODUCTION

Southwestern Oklahoma¹ lies close to the eastern limit of the southern Great Plains. It is drained by intermittent streams, tributary to the Red River, which flow south by east. Most of the streams are small but frequently overflow with considerable damage to adjacent bottom lands. Much of the farmland bordering creeks and rivers is highly productive for alfalfa, cotton, and broomcorn.

This area was opened to homesteading in 1901. Since then it has undergone a rapid transition from well-grassed plains supporting large herds of grazing beef cattle to cropped lands with numerous farm homes. The settler who came to southwest Oklahoma in 1901 could not plan his farming in the light of any local experience. Typically, after breaking the native sod he planted crops that were grown in some area where he had previously farmed, and tilled them by methods to which he had been accustomed. The settlers came chiefly from less arid areas in States such as Iowa, Kansas, Missouri, Arkansas, and Texas. Harassed by devastating storms, heat, frost, floods, and drought, most of them soon tried to change to crops and tillage methods better adapted to the local climate. This effort involved many mistakes. More than 15 years passed before any agricultural research agency directly serving the area had begun to supply information helpful to the farmer. In the meantime, however, some keenly observant settlers had avoided most of the common mistakes and developed cropping practices that were well adapted to local conditions.

The native grass range at the time of white settlement was composed chiefly of big bluestem (*Andropogon gerardi*), little bluestem (*A. scoparius*), side-oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), and buffalo grass (*Buchloe dactyloides*). As the farms developed, acreages available for grazing became restricted and overgrazing resulted. Less desirable native grasses, some with a short season and all with lower palatability, became established in the native pastures and reduced their value. The more important of these were switchgrass (*Panicum virgatum*), downy chess (*Bromus tectorum*, commonly known as cheat grass), and dropseed (*Sporobolus* sp.).

¹ The area referred to in this publication as southwestern Oklahoma includes roughly these counties: Grady, Stephens, Jefferson, Caddo, Comanche, Cotton, Custer, Washita, Kiowa, Tillman, Beckham, Greer, Jackson, and Harmon. Research findings presented here apply not only to this area but to a contiguous part of northern Texas.

During the transition from vast unfenced grazing areas to farms and ranches, a heavy toll was taken by droughts, floods, destructive crop insects, and erosion. Use of better adapted crops and improved farm practices have reduced crop hazards. Reseeding of wornout or overgrazed farmlands with native and introduced grasses has met with moderate to good success.

The long growing season of southwestern Oklahoma permits production of a wide variety of crops, of which the more important are cotton, alfalfa and other legumes, grain and forage sorghums, and—except on the sandy soils—wheat, barley, and oats. These more important crops are grown in rotations. The small grains have now become much more valuable because they are used not only as cash crops but for grazing and because improved varieties and production methods have been developed. Alfalfa acreage on creek and river bottom land in the area has gradually increased, and the crop is highly important on these restricted areas. Early maturing corn has been and is being grown with moderate success on bottom lands and on sandy soils. The value of sweetclover as a soil-building crop has led to many efforts to include it in cropping systems in the area, and these efforts have been moderately successful in years of well-distributed rainfall. Hairy vetch is now finding an important place in cropping systems for the sandy soils of southwestern Oklahoma.

The Lawton Field Station was established by the Federal Government at Lawton, in Comanche County, Okla., in 1915 to study the crop possibilities and limitations of southwestern Oklahoma. The station's experimental area was then in virgin sod. Its first crop was grown in 1916 on land broken from sod in 1915 and uniformly prepared. From 1917 on, the major field crops of the area were grown at the station in fixed sequences, by various tillage methods. Cooperation was maintained formally or informally with the Oklahoma Agricultural Experiment Station; the Divisions of Cotton and Other Fiber Crops and Diseases, Cereal Crops and Diseases, and Cereal and Forage Insects of the United States Department of Agriculture; the United States Weather Bureau; and the Kiowa Indian Agency. In 1949 the station was discontinued and the land turned back to the Kiowa Indian School. This publication principally summarizes the experimental work in crop rotation and tillage from 1924 through 1949. It briefly discusses work of the station along other lines that has not been reported elsewhere—date-of-seeding and variety tests of winter barley, a comparison of fall-sown and spring-sown oats, a study of the nitrogen content of the soil as affected by cropping, and experiments in using commercial fertilizers, in seeding grasses, and in growing grapes, trees, and ornamental shrubs. Together with experimental results it presents some observations on general experience and present-day trends in practical agriculture in southwestern Oklahoma.

Work done at the station has previously been reported in journal articles, in 8 bulletins of the Oklahoma Agricultural Experiment Station, and in 1 bulletin of the Department of Agriculture (5, 10, 15, 18, 20, 22, 24-28).²

² Italic numbers in parentheses refer to Literature Cited, p. 44.

CLIMATE

PRECIPITATION

Annual precipitation at the Lawton station in the period 1916-49 averaged 28.70 inches. It ranged from 17.23 inches in 1939 to 43.92 inches in 1941. Among monthly precipitation averages of the growing season those for July and August were the lowest. Monthly precipitation reached its spring and fall peaks in May and October (fig. 1).

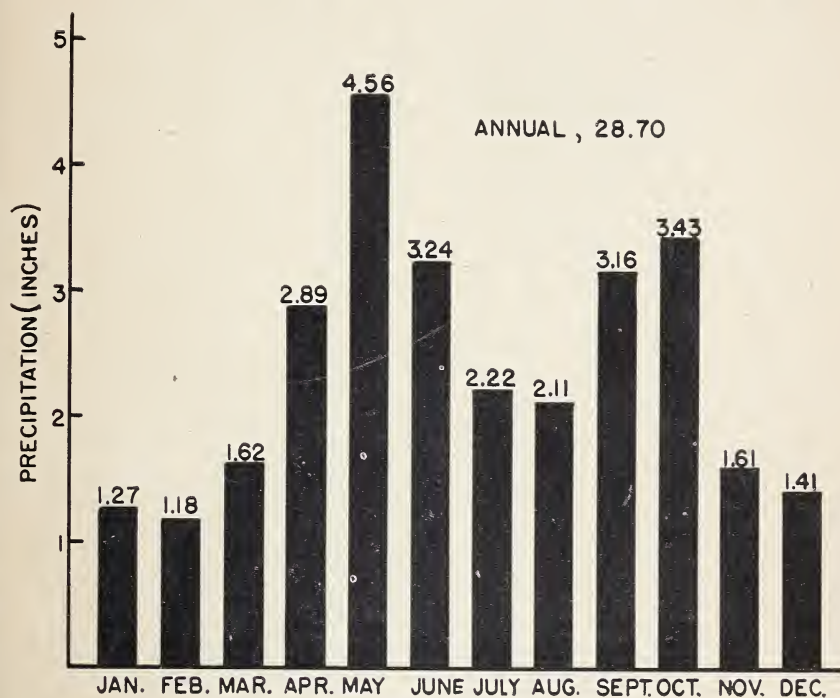


FIGURE 1.—Monthly averages of precipitation at the Lawton Field Station, 1916-49.

On an average, 63 percent of the annual precipitation occurred during the 6-month period April-September. The extremes in precipitation totals for each month of the growing season were as follows:

Month	Precipitation extremes in 1916-49	
	Minimum Inches	Maximum Inches
April.....	0. 01	6. 85
May.....	. 90	14. 12
June.....	. 25	8. 01
July.....	. 07	6. 28
August.....	0	7. 48
September.....	0	10. 36
October.....	. 03	13. 78

Southwestern Oklahoma's average yearly total of precipitation is sufficient to make the area subhumid rather than semiarid if the yearly total and its distribution did not vary so widely. Good crops have been grown in the area in years when precipitation totaled only slightly above 20 inches, and poor crops in years when it totaled 30 inches or higher. The length and severity of droughts during periods critical for crop development are the strongest determinant of yield. Periods in which the weather favors lush growth of vegetation are frequently followed by prolonged drought and heat. Not only is the distribution of rainfall erratic, but characteristics of the soil limit the depth to which crops can feed regularly. The soil does not hold water readily available in such quantities that crops can escape injury by an extended period of drought or, when temperatures are extremely high, even a medium period of drought. Consequently the area is no less subject to drought losses than many having much less rainfall.

The year 1949 offers a good illustration of how drought at a critical time can affect crop yields in southwestern Oklahoma. Precipitation was ample from early spring until late June, and crop prospects were excellent. Low precipitation in July and much of August changed a prospective bumper crop into a mediocre one, even though temperatures were a little below normal.

Monthly and annual totals and averages for precipitation at the Lawton Field Station in 1916-49 are given in table 16, appendix.

TEMPERATURES AND FROST-FREE PERIOD

Temperatures at Lawton in the 34 years 1916-49 ranged from as high as 115° F. to as low as -9°. The yearly maxima have been equaled or exceeded by those at many other locations in the Great Plains. Summer temperatures usually were moderately high for a long period (table 17, appendix). In 1916-49 temperatures of 100° or more occurred repeatedly in every month from May through October. In the whole 34-year period the monthly maximum for July never fell short of 100° and that for August did so only once. The maxima for June and September reached or exceeded 100° in half the years. At Lawton a temperature of 100° or a little more is not oppressive when the humidity is below the local average. In July and August the monthly minimum temperature was usually 60° or higher and daily minima were generally in the higher sixties or low seventies. Uninterrupted moderate to high temperatures are conducive to a lush growth of crops when moisture conditions are favorable, but such a growth generally becomes a handicap if favorable moisture conditions cease.

The average frost-free period for the 33 years 1917-49 was 214 days, extending from April 2 to November 2 (table 18, appendix). Late maturing cotton is the only local crop likely to be injured by fall frosts. Spring frosts are not likely to injure field crops in the area but may damage fruit and truck crops.

WIND VELOCITY

Monthly average wind velocity was low except in March, when it was about 8 miles per hour, and in April, when it was about 7.5 miles per hour (table 19, appendix). The prevailing wind during the growing season comes from the southwest.

Wind velocity was measured with an anemometer exposed at a height of 2 feet above the ground, which approximates the height levels of field crops.

EVAPORATION

The evaporation at the Lawton station for the 6 months April-September averaged 45.29 inches and that for the 8 months April-November averaged 52.82 inches (table 20, appendix). Evaporation was low compared with that at any of the other dryland stations in the southern Great Plains but often was excessive; during drought periods it sometimes exceeded one-half inch in a single day.

Evaporation was measured in a tank 6 feet in diameter and 24 inches deep. The tank was sunk in the ground to a depth of 20 inches and was kept filled with water to about the ground level.

SOIL CHARACTERISTICS

The soil of the experimental area was classed as Lawton silt loam, a type representative of the heavy upland soils of southwestern Oklahoma. It was reddish-brown in color and had fairly good natural fertility. Soil depth on the area ranged from about 3 feet to more than 6 feet. A layer of strongly weathered gravel mixed with clay and other fine material was found at depths ranging from less than 1 foot to more than 3 feet. The location of this layer appeared to have little to do with crop growth; no difference in crop growth was observed between areas where gravelly material occurred at a depth of less than 18 inches and areas where the soil was free from gravel to a depth of 3 feet or more. The presence of the gravel layer did have the effect of making soil-moisture sampling so difficult and unreliable that attempts at soil-moisture determinations were discontinued after the first few seasons.

No soil samples from the experimental area were analyzed before cropping was started, but samples from a virgin area having soil of the same type within a few hundred feet of the experimental area were analyzed in 1947. The average nitrogen and carbon contents of these samples are given in table 1, and the mechanical analysis, by depth, in table 21, appendix. It is believed that these samples represented

TABLE 1.—*Nitrogen and carbon content and carbon-nitrogen ratio of virgin Lawton silt loam*¹

Depth (inches)	Nitrogen ²	Carbon ³	C/N ratio ³
	<i>Percent</i>	<i>Percent</i>	
0-6.....	0. 158	1. 94	11. 8
6-12.....	. 106	1. 13	11. 2

¹ Samples were taken within a few hundred feet of the Lawton Field Station and were analyzed at the Northern Great Plains Field Station, Mandan, N. Dak.

² Average for 9 duplicate samples.

³ Average for 3 duplicate samples.

the virgin condition of the soil of the experimental area rather accurately. The profile of the virgin Lawton silt loam analyzed was described ³ as follows:

Lawton silt loam: Profile 47Ok 16-1

In native pasture just north of Lawton Field Station on land belonging to the Indian Mission of the Reformed Church in America. Located in Comanche County, Okla., about 2 miles north of Lawton in SW 1/4 of SE 1/4 section 19, T. 2 N, R. 11 W. Samples collected from a pit by L. T. Alexander and E. H. Templin, April 28, 1947.

Gently undulating prairie; lightly pastured; vegetation is largely of unidentified short and mid-grasses, probably including one or more grammas and buffalo grass. No *Andropogons* were seen but they may have been an important part of the vegetation before pasturing. The surface is freely drained, with gradient of about 1 percent, and weakly convex.

Plant roots were present and comparatively numerous to the greatest depth examined, 61 inches. The soil was moist throughout (approximately at field capacity) at the time of sampling, which was after a winter of about average rainfall.

1. 0-6 inches, A₁ horizon. Brown (7.5YR 4/2; 2.5/2, moist) silt loam; strong fine granular; friable; noncalcareous. Sample 47Ok 16-1-1

2. 6-12 inches, A₂ horizon. Brown (7.5YR 4/3; 3/3, moist) heavy silt loam; friable; strong fine granular; grades into horizon below. Sample 47Ok 16-1-2

3. 12-15 inches, A₃ horizon. Reddish-brown (5YR 4/4; 3/3, moist) silty clay loam; very strong medium granular; noncalcareous; friable; grades below. Sample 47Ok 16-1-3

4. 15-19 inches, B₁ horizon. Reddish-brown (5YR 4/4; 3/4, moist) silty clay; friable; strong medium granular; grades below. Sample 47Ok 16-1-4

5. 19-30 inches, B₂ horizon. Reddish-brown (4YR 3.5/4; 4/5, crushed; 3/4, moist uncrushed; 4/6, moist crushed) clay; firm; permeable; compound moderate medium granular and medium prismatic; color is slightly variegated; passes into layer 6 through a 1-inch transition. Sample 47Ok 16-1-5

6. 30-35 inches, B₃ horizon. Partly weathered igneous pebbles in an equal volume of red (3YR 3/6) clay; granular; lower boundary sharp. Sample 47Ok 16-1-6

7. 35-45 inches, C₁ horizon. Red (3.5YR 3/5; 3/6, moist) clay; strongly prismatic; roots abundant in the crevices between prisms, outsides of prisms shiny; firm but slowly pervious; noncalcareous; grades below. Sample 47Ok 16-1-7

8. 45-54 inches, C₂ horizon. Red (3YR 4/6, moist) sandy clay; friable to firm; strong coarse prismatic; exteriors of prisms are coated with dark-brown films; concretions of black crystalline minerals, probably magnetite (?), are abundant; grades through 2-inch transition to layer below. Sample 47Ok 16-1-8

³ In a memorandum dated March 6, 1948, by E. H. Templin, who, with L. T. Alexander, had selected the sampling location.

9. 54-61 inches, plus. C₃ horizon. Partly weathered waterworn igneous gravel in a matrix of noncalcareous clayey fine earth. Sample 47Ok 16-1-9

The soil of the experimental area was found to be pervious to water and roots to at least 5 feet; plant roots were found at the lowest depth reached, 61 inches. The high silt and clay content of the first 4 feet of soil (table 21, appendix) no doubt retarded penetration of water and probably inhibited ready penetration of roots in times of sudden stress.

CROP HAZARDS OTHER THAN THOSE OF CLIMATE

PLANT DISEASES

Plant diseases are an annual threat to crops in southwestern Oklahoma.

Some of the major diseases of wheat, oats, and barley can be controlled by seed treatment. Diseases of small grains that can be controlled in this way include the smuts of wheat, oats, and barley and the stripe disease of barley. Those that have not been controlled satisfactorily by seed treatment include western dryland foot rot, leaf rust, and septoria on wheat and crown rust on oats. The breeding of resistant varieties offers the greatest promise of eventual control of these diseases. Stem rust in southwestern Oklahoma usually appears too late in the season to offer a serious problem. Winter barley in the area has been comparatively free from stripe rust, scab, and powdery mildew.

Grain and forage sorghums and broomcorn are susceptible to diseases that often cause crop losses (19). These diseases (1) reduce the stand by rotting the seed or by killing the seedlings; (2) affect the leaves and reduce the value of the forage; (3) affect the heads and prevent normal grain development; and (4) involve rot of roots or stalk and prevent normal development and maturing of the plant. The outstanding importance of sorghums, which are grown for forage, grain, sirup, broom making, and a certain kind of starch, makes it very desirable to recognize these diseases and use all possible means of control.

Various seedborne and soil-inhabiting fungi do damage to sorghum particularly when the soil is cold and wet. Prompt germination of sorghum seed requires a soil temperature above 70° F. Control measures include careful selection of well matured and properly cured seed. Before being planted, the seed should be dusted with some good disinfectant that will give protection from seedborne fungi and to some extent from harmful soil fungi.

The three bacterial leaf diseases stripe, streak, and spot may occur wherever sorghum is grown, especially when moist weather with temperatures of 75° to 85° F. prevails. These diseases generally do not develop until the plants are nearing full growth, but they may spread over the leaves very rapidly, reducing the forage value of the crop and causing some shrinkage of the kernels.

The three smuts of sorghum are covered kernel smut, loose kernel smut, and head smut. Control measures for the first two of these include seed treatment, use of smut-free seed only, and use of smut-

resistant varieties. At present, seed treatment is the most effective. Although head smut destroys the entire head, it is the least important of the three. Sanitation seems to be the one effective means of controlling it.

Root and stalk diseases of sorghum include pythium root rot (milo disease), weak neck, and several stalk rots. Practically all the grain sorghums grown commercially at the present time are resistant to root rot, but none of the commercial varieties or strains is free from charcoal rot of the stalks. Charcoal rot is characterized by a breaking over of the stalks (fig. 2). Weak neck is an important factor now that combine harvesting of sorghums has become prevalent. In weak neck the upper part of the stalk (peduncle) bends over and breaks,



FIGURE 2.—A, Charcoal rot damage to susceptible variety of sorghum; B, resistant selection exhibiting no injury.

with the result that the head falls to the ground and is lost. Weak neck is not a parasitic disease; it is a characteristic of certain varieties—most of which are adapted to the Lawton area. The remedy is to grow varieties the stalks of which remain green for a considerable period after the grain ripens. Such varieties include Westland, Midland, and Kalo Selection H. C. 617.

Bacterial blight, or angular leaf spot, is present on cotton in southwestern Oklahoma nearly every year and has frequently almost defoliated young cotton plants when they were 6 to 12 inches high. Progress has been made in controlling it by using disease-free seed, treating seed with organic mercury compounds, and developing resistant varieties. Wilt and cotton root rot cause considerable damage to cotton along the southern boundary of Oklahoma within 50 miles of Lawton.

Detailed information on controlling crop diseases through seed treatment, cropping practices, or use of resistant crop varieties can be obtained from county agents or State agricultural experiment stations.

DESTRUCTIVE INSECTS

Insects injurious to crops have taken a heavy toll in southwestern Oklahoma, forcing control measures and changes in farm management practices. On the station they made necessary many changes in cropping practices; they limited the numbers of crops and crop varieties that could be grown and influenced the time of planting and the field management of certain crops.

Chinch bugs, greenbugs, armyworms, wheat stem maggots, and grasshoppers all damage wheat, oats, and barley. Sorghum and corn are particularly subject to attacks by the chinch bug. This insect migrates to corn and sorghum when the small grains approach maturity and feeds on them the rest of the season. The damage usually becomes more intense with each successive generation. The chinch bug has been the limiting factor in the production of many of the grain sorghums, such as milo, except on sandy land where the small grains are not grown. The abundant chinch bug population at Lawton made the station a desirable location for studying the biology of this insect and for breeding sorghums resistant to the chinch bug (fig. 3). Results of efforts along these lines have been reported in numerous publications (3, 4, 6-9, 11-15, 23, 29-32).

Cotton is attacked by the bollworm, boll weevil, aphids, and pink bollworm. Alfalfa, also, is attacked by aphids.

New and better insecticides and improved equipment for applying them promise more rapid and effective control than has heretofore been possible. Current recommendations on measures for controlling crop insects can be obtained from county agents, State agricultural experiment stations, and the United States Department of Agriculture.

BIRD DAMAGE

Constant precautions were required to protect the sorghums from bird damage. The many trees in the city of Lawton and along nearby Cache Creek furnish homes for many birds. These, together with flocks of migrating birds, created a serious problem at the station. Constant efforts to frighten the birds away reduced bird damage but



FIGURE 3.—Dwarf Yellow milo in the center row has been almost completely destroyed by chinch bugs. At the right is a chinch-bug-resistant hybrid of which Dwarf Yellow milo was one of the parents.

did not eliminate it. Early maturing sorghum varieties, which become attractive to birds before the crops generally grown in the locality do so, were often seriously damaged. Bird injury to varieties that mature later was less concentrated but nevertheless considerable. The grain yield of the sorghums grown in rotation experiments was reduced by birds in many years. This hazard applied more particularly to the station than it does to southwestern Oklahoma as a whole.

SOIL EROSION

Water erosion of the soil is serious in the Lawton area; wind erosion is of minor importance. The torrential character of many summer and fall rains and the slowly permeable nature of the soil combine to intensify runoff and the consequent erosion problem. Land where a clean cultivated crop is being grown is especially subject to abnormal erosion, and even the most approved methods of handling the land do not entirely protect it.

Some soils, particularly on slopes, are so subject to erosion that only a return to a soil-binding crop such as grass can prevent their eventual

impoverishment or destruction. All the soils require careful handling for control of erosion.

On the station, erosion was most serious where cultivated crops were grown continuously or frequently and on some of the roads. A minor amount of sheet erosion took place on all the land.

Information on methods of handling soil of various types to minimize erosion may be obtained from State agricultural experiment stations or the Soil Conservation Service.

PROCEDURE IN ROTATION AND TILLAGE EXPERIMENTS

In the rotation and tillage experiments, plantings of each crop in any year were made with the same variety, usually one of the better adapted ones, with a view to excluding variables other than crop sequence and tillage method. More productive and less productive cropping methods, respectively, were practiced on about half the plots of each of the crops kafir, cotton, wheat, and cowpeas. For other crops, the division was less even.

Facilities of the station did not permit evaluating the different small-grain crops and varieties for grazing.

Every combination of crop and tillage method in every rotation and tillage experiment was represented every year, on a $\frac{1}{10}$ -acre plot. Thus each experiment occupied as many plots as there were years in the rotation.

When the rotation and tillage experiments began, in 1916, all the rotations were tested on adjoining plots (21). For example, small grains, sorghums, and corn were grown side by side in the same field. It soon became evident that the proximity of small plots, by making it easy for chinch bugs to migrate between crops, intensified insect injury much beyond that occurring on farms. As a consequence the plan of work was revised in 1922 and 1923 so that all plots of corn and sorghum were in one field, designated field A, and all plots of small grain, except two oats plots, were in a separate field designated field B (fig. 4). Crops unattractive to chinch bugs, such as cotton and cowpeas, were grown in both fields. Soil amendments in the form of stable manure or of green manure were stressed in the experiments in field B.

The rotations, and the tillage methods used in the rotation tests, were the following:⁴

Field A:

3-year rotations:

- No. 160. Kafir, kafir, cowpeas. All s. p.
- No. 161. Kafir, cowpeas, feterita. All f. p.
- No. 162. Kafir, cowpeas, feterita. All s. p.
- No. 163. Kafir, feterita, cowpeas. All f. p.
- No. 165. Kafir (f. p.), fallow, feterita.
- No. 166. Cotton (disked), feterita (s. p.), cowpeas (s. p.).
- No. 167. Cotton (disked), kafir (s. p.), cowpeas (s. p.).
- No. 168. Feterita (f. p.), fallow, kafir.
- No. 169. Feterita, cowpeas, kafir. All s. p.
- No. 205. Cotton (f. p.), cowpeas (f. p., plowed under), feterita.

⁴ S. p.=spring plowed. F. p.=fall plowed. S. clover=sweetclover. "Top-dressed," here and elsewhere in this publication, means topdressed with manure.



FIGURE 1.—Aerial view of the Lawton Field Station. Field A appears in the right foreground, field B in the right center. The road at the right of field B is a station boundary.

4-year rotations:

- No. 133. S. clover, s. clover, cotton (f. p.), cowpeas (f. p.).
- No. 134. S. clover, s. clover, cotton (f. p.), kafir (lister planted).
- No. 274. Kafir (s. p.), sorgo (drilled, f. p.), corn (f. p.), cotton (f. p.).
- No. 275. Cotton (f. p.), cotton (f. p.), kafir (s. p.), sorgo (drilled, f. p.).
- No. 276. Cotton, oats, kafir (manured), cowpeas. All f. p.

6-year rotation: No. 142. Alfalfa, alfalfa, alfalfa, oats (f. p.), corn (s. p.), cotton (s. p.).

Field B:

2-year rotations:

- No. 260. Wheat (disked), cotton (s. p.).
- No. 261. Wheat (f. p.), oats (f. p.).
- No. 262. Wheat (f. p.), oats (disked).
- No. 264. Wheat (f. p.), spring barley (disked).
- No. 265. Wheat (disked), cowpeas (s. p.).
- No. 266. Wheat on cowpea green manure, cowpeas (s. p., plowed under).
- No. 267. Wheat, fallow.
- No. 268. Wheat, fallow (manured).
- No. 269. Wheat (topdressed), fallow.
- No. 364. Wheat (topdressed), cowpeas (s. p.).
- No. 390. Cotton, rye (plowed under).
- No. 391. Cotton (f. p.), oats (disked).
- No. 392. Cotton (f. p.), wheat (disked).
- No. 393. Cotton (s. p.), peanuts or Mung beans (s. p.).
- No. 394. Cotton (s. p. and topdressed), cowpeas (s. p.).
- No. 395. Cotton (s. p.), cowpeas (s. p.).
- No. 396. Cotton on cowpea green manure, cowpeas (s. p., plowed under).
- No. 397. Cotton, fallow.
- No. 398. Cotton, fallow (manured).
- No. 399. Cotton (topdressed), fallow.

3-year rotations:

No. 195.	Cotton (f. p.), cotton (f. p.), wheat.
No. 196.	Cotton (f. p.), cowpeas (f. p.), winter barley.
No. 197.	Cotton (f. p.), wheat, wheat (f. p.).
No. 198.	Cotton (f. p. and topdressed), cotton (f. p.), wheat.
No. 199.	Cotton (f. p.), cowpeas (plowed under), wheat.
No. 200.	Cotton (s. p.), cowpeas (s. p.), wheat.
No. 201.	Cotton (f. p.), cowpeas, (f. p.), spring barley.
No. 202.	Wheat, cowpeas (plowed under), cotton.
No. 203.	Cotton (f. p.), cowpeas (f. p.), wheat.
No. 204.	Cotton (f. p.), wheat (topdressed), wheat (f. p.).

Continuous and alternate cropping with cotton, kafir, sorgo, corn, and feterita by different tillage methods was practiced on field A. Continuous cropping with wheat by different tillage methods was practiced on field B. In the tillage experiments with wheat, the tillage necessary to control weeds was given to all the plots from the time tillage began until seeding time. All row crops were kept substantially free from weeds.

Peanuts were grown in rotation with cotton in 1924-42. Mung beans were grown as a hay crop in rotation with cotton in 1943-49. Broomcorn was grown in 1917-33.

Castor beans and flax were grown for a number of years on the station but not in tillage tests.

The varieties of principal crops grown in the rotation and tillage experiments and the years in which they were grown are as follows:

Cotton:	Acala and improved strains of Acala	1924-49.
Wheat:		
	Turkey Red	1924-26, 1928-45.
	Kanred	1927.
	Comanche	1946-49.
Kafir:		
	Reed	1924-39, 1942-48.
	Sharon	1940, 1949.
Feterita:		
	Dwarf	1924-26.
	Spur	1927-45.
	Kafirita	1946-49.
Sorgo: Sumac		1924-49.
Corn:		
	Silvermine	1924.
	Surecropper	1925.
	Bloody Butcher	1926-30.
	White June	1931.
	Hays Golden	1932-49.
Cowpeas:		
	Blackeye	1934, 1936-42, 1946-49.
	Early Buff	1924-28.
	Chinese White	1929-32, 1943.
	Brown Crowder	1933.
	Texas Velvet Pod	1935.
	New Era	1944-45.
Spring Barley:		
	Common	1924-25.
	Manchuria	1926-39.
	Wintex	1940-44.
	Tenkow	1945-49.
Winter barley:		
	Wisconsin	1924-45.
	Tenkow	1946-49.

Spring oats:	
Fulghum.....	1924-43.
New Nortex.....	1944-48.
Fultex.....	1949.
Alfalfa: Oklahoma Common.....	1924-49.
Sweetclover:	
Common White.....	1924-31.
Madrid Yellow.....	1932-49.

YIELDS AND RELATIVE ADAPTATION OF CROPS

Two crop-yield factors of particular importance are total production and dependability of production. These are indicated by the average yields and the annual yields (table 2).

Cotton, with an average acre yield of 229 pounds of lint and 377 pounds of seed, was one of the most dependable crops. It never failed completely, and its yield seldom averaged extremely low. Cotton occupied about one-third of the cultivated acreage during the first 40 years of farming in southwestern Oklahoma. This acreage has since been greatly reduced for reasons other than relative adaptation.

Winter wheat likewise performed dependably. Its only complete failure occurred in 1946, when the crop was destroyed by greenbugs. Largely because of the crop's value for grazing and its relatively high average yield of 15.1 bushels to the acre, wheat acreage has shown a marked increase. Improved varieties and, more particularly, improved equipment and methods of production have contributed to this increase.

Oats are another dependable small grain, the popularity of which as a crop has been greatly enhanced by new winter-hardy varieties. No winter oats were grown in the rotations, but variety trials (27) have shown them to be much more dependable and productive than spring-sown oats. They have largely replaced the latter on farms in southwestern Oklahoma. Winter oats have numerous advantages, including production of winter and early-spring pasture, less rust damage (because of early maturity), less erosion during the winter months, and less damage from late-spring freezes and from insects.

Winter barley is fairly well adapted to the climate of southwestern Oklahoma, but its production has been held to a minor place by greenbugs (1), chinch bugs, and fungus diseases. If these were controlled, winter barley would have place as a pasture crop—for farm animals, like insects, exhibit a marked preference for it.

The grain and forage sorghums, which have long been dependable producers of feed and cash income, have become still more valuable in recent years because of spectacular improvement. Development of grain sorghum varieties that can be harvested with a combine has eliminated much of the labor connected with harvesting and has consequently reduced production costs. Forage sorghums have been improved in palatability. At present, in southwestern Oklahoma, most sorghums grown for grain are of a combine type and sweet sorghums (sorgos) are grown for forage. The varieties grown in the rotation tests are not necessarily the ones of most importance today, but they give a good picture of the dependability of the best varieties.

Kafir is a good representative of the dual-purpose sorghums. Both its forage and its grain are of excellent quality. No complete failure of kafir stover occurred in the experiments. The grain yields tabulated

TABLE 2.—Annual and average acre yields of crops grown in rotation and tillage experiments at Lawton, Okla., 1924-49

Year	Yields per acre																				
	Kafr		Pot- erta grain	Sorgo		Cotton		Corn		Winter wheat	Spring oats	Barley		Cow- pea hay	Sweetclover hay		Alfalfa hay				
	Grain	Stover	Bn.	Lb.	In cul- tivated rows ¹	Drilled	Lint	Seed	Grain	Stover	Bn.	Lb.	Winter	Spring	Bn.	Lb.	1st year	2d year	1st year	2d year	3d year
1924	29.0	4,533	24.6	8,157	3,171	2,780	313	511	16.8	1,650	38.5	20.8	69.2	27.1	20.8	2,089	Lb.	Lb.	Lb.	Lb.	Lb.
1925	11.8	1,920	7.0	3,171	7,200	14,775	230	345	8.4	800	5.7	20.8	20	3.7	20.8	1,203	0	1,450	2,850	3,450	Lb.
1926	21.4	3,035	15.6	7,200	10,800	257	416	416	8.4	1,417	25.6	42.6	48.3	21.0	42.6	1,124	0	1,750	2,700	800	0
1927	20.2	2,213	12.6	5,591	10,800	510	800	800	21.9	1,344	17.4	21.1	29.4	3.0	29.4	2,509	0	0	1,950	3,200	0
1928	30.5	3,893	25.7	9,257	9,625	204	351	351	20.2	1,700	13.2	34.3	16.7	13.5	34.3	1,438	0	0	1,500	1,000	0
1929	21.2	3,318	25.6	7,792	11,300	228	365	365	28.0	1,811	10.8	26.6	11.0	13.4	26.6	3,288	750	0	1,400	3,300	0
1930	0	1,645	4.5	1,665	64	107	64	107	6.7	1,018	5.5	31.6	2.0	8.0	31.6	1,176	0	0	1,450	1,600	0
1931	27.8	4,694	33.4	8,779	10,425	309	595	595	12.6	2,617	28.3	66.2	50.4	24.8	66.2	3,007	1,400	2,250	2,300	2,500	0
1932	29.5	4,791	19.2	8,980	14,950	272	474	474	27.3	2,194	28.8	37.6	42.1	11.3	37.6	2,562	1,550	2,500	2,300	2,450	0
1933	0	2,598	0	4,229	4,000	311	573	573	6.9	1,883	17.8	35.1	21.9	10.1	35.1	2,506	0	0	1,300	1,750	0
1934	0	1,590	0	2,614	2,375	42	87	87	4.6	2,290	11.3	19.3	21.9	13.8	19.3	1,759	0	0	600	650	0
1935	0	2,901	12.1	4,807	4,675	104	189	189	23.9	1,489	10.5	43.6	2.0	6.6	43.6	1,721	0	0	1,400	1,250	0
1936	0	1,369	0	2,234	1,900	15	35	35	12.1	1,289	9.4	17.3	0	18.1	17.3	1,076	0	0	600	650	0
1937	13.2	2,317	13.2	4,829	9,575	71	139	139	19.9	1,817	28.2	38.1	49.8	18.1	38.1	2,221	0	0	1,300	1,550	0
1938	23.8	3,995	19.7	5,863	11,225	160	272	272	25.5	1,572	8.5	10.6	3.0	4.8	10.6	3,121	0	0	1,300	1,300	0
1939	0	1,482	0	1,879	4,175	144	272	272	8.6	1,222	3.9	9.6	2.7	2.7	9.6	1,115	0	500	0	750	0
1940	29.1	3,465	26.7	9,036	9,700	268	454	454	28.0	1,933	11.1	16.1	4.4	7.9	2,824	2,175	1,975	600	500	1,150	0
1941	28.1	3,853	20.7	8,610	23,450	338	512	512	36.9	1,672	9.8	32.7	37.9	5.4	32.7	2,588	3,550	3,550	6,300	2,300	0
1942	17.8	2,913	13.3	6,801	13,375	457	719	719	24.5	2,100	3.2	4.0	4.0	0	4.0	2,294	2,500	2,800	0	0	0
1943	0	3,128	3.9	5,290	8,050	129	223	223	27.8	1,667	13.9	17.5	4.2	1.5	17.5	1,162	1,175	1,175	2,000	1,700	0
1944	23.9	2,637	9.0	5,523	7,200	199	369	369	22.3	1,344	22.8	29.0	29.2	12.5	29.2	2,503	0	2,400	650	1,400	0
1945	0	3,894	16.1	9,816	10,850	337	537	537	27.8	1,333	15.9	24.3	35.2	5.4	35.2	2,635	0	4,200	4,750	4,750	0
1946	0	2,943	0	5,510	12,225	177	286	286	27.6	1,121	4.0	41.0	4.0	4.8	41.0	1,209	2,275	2,980	1,530	2,000	0
1947	0	2,755	12.2	3,971	3,725	182	279	279	18.7	1,383	20.3	41.6	19.8	2.9	41.6	2,268	0	3,250	2,750	2,800	0
1948	23.8	3,586	28.3	5,829	11,425	343	526	526	22.1	1,672	21.1	7.0	13.1	13.1	7.0	2,671	0	1,575	950	1,100	0
1949	12.7	1,437	14.7	5,465	7,550	286	359	359	26.1	1,493	10.2	41.0	16.9	12.5	41.0	2,568	0	1,125	0	300	0
Average	14.1	3,099	13.4	5,913	9,136	229	377	377	19.4	1,601	15.1	29.1	19.5	9.0	29.1	2,067	409	1,709	363	1,781	1,663
Plots, number	30	30	11	7	2	48	9	48	9	9	31	5	1	2	5	17	2	2	1	1	1
Years, number	26	25	26	25	26	26	26	26	26	26	26	26	26	26	26	26	17	17	26	26	26

¹ Values include grain yield. For the 2-year period, this averaged 637 pounds per acre per year.² Winterkilled (plots reseeded to spring barley).³ Destroyed by hail.⁴ Destroyed by greenbugs.⁵ Destroyed by birds.⁶ Average yield of 9 plots.⁷ Destroyed by elench bugs.

Crop on all other plots destroyed by birds.

do not truly reflect the production that should be attained in southwestern Oklahoma. Planting on the station had to be done earlier than is best for the crop, in order to reduce chinch bug damage. The early planting caused kafir to ripen earlier on the station than it does generally in southwestern Oklahoma, and this resulted in greater bird damage. In some years, birds completed the grain failure of drought-injured kafir crops. Most kafir grain failures are due not to a single cause but to a combination of drought with insect or bird damage or with disease. The increased use of combine-type sorghums has reduced the acreage of kafir varieties such as Reed and Sharon.

Feterita has been of some importance in southwestern Oklahoma as a catch crop, but its grain yield averages lower than that of kafir and its stover is much less palatable. In recent years it has been almost completely replaced in the area by feterita-kafir hybrids, such as kafirita, that are much less susceptible to the chinch bug.

Sorgo (of the Sumac variety) produced consistently good yields of fodder, averaging nearly 3 tons of air-dry material to the acre. In only 1 of the 26 years did the yield fall below a ton to the acre. Sorgo's total grain and stover yield was nearly 50 percent higher than that of kafir. Sorgo planted with a grain drill produced an average yield of more than 4.5 tons to the acre. In comparison with sorgo in cultivated rows it yielded much more forage, in productive years.

The fact that alfalfa, although highly important on creek and river bottom lands in southwestern Oklahoma, has not gained favor on the uplands can be attributed to the general undependability of its production and its prevailing poor first-year production. The fair yield averages of alfalfa in the second and third years after planting on the station plots—more than $\frac{3}{4}$ ton per acre—resulted from very good yields in a few years rather than from fair yields each year. Second- or third-year yield amounted to less than 1,000 pounds to the acre in nearly one-third of the instances. Newly planted alfalfa produced a measurable crop in only 8 of the 26 years.

Cowpeas (fig. 5) were the most dependable source of legume hay on the heavy soil of the station. The acre yield of cowpea hay on the plots averaged more than a ton for the study period and fell below 1,000 pounds in only 1 year.

The sweetlover yield data do not cover all the time that sweetclover was grown at the Lawton station. Prior to 1933, however, the seed was sown broadcast and the crop failed more often than it succeeded. From 1933 onward, sweetclover was grown in paired cultivated rows and good stands were obtained except in the severe drought years of the early thirties. On the rotation plots sweetclover was harvested for hay. A good yield—or, in fact, a yield of any kind—was seldom obtained in the year of seeding. Second-year production was fairly good. Elsewhere on the station, good yields of sweetlover seed were obtained frequently. The seed was harvested with a row binder (fig. 6). The same method can be used for sweetlover hay. It eliminates the dirt contamination that takes place when sweetlover in cultivated rows is harvested with regular haying equipment.

The grain yield of corn exceeded that of kafir somewhat, but part of the excess was due to freedom from bird damage. The acre yields do not tell the whole story. In more than half the years the grain



FIGURE 5.—Chinese White cowpeas (station strain) growing on the Lawton Field Station. This crop produced, on an average, more than a ton of hay per acre.



FIGURE 6.—Using a row binder to harvest sweetclover, grown in paired cultivated rows, for seed.

was of poor or very poor quality. Stover yields were low in comparison with those of sorghum, and in a number of years the corn stover was worthless. Corn does not compare well with sorghums for all-around use on the tight upland soils.

Good peanut crops were obtained occasionally, but in more than half the years the crop failed, frequently because of damage by rabbits. The hay yield of Mung beans averaged about 260 pounds per acre lower than that of cowpeas during the same period. For broomcorn, failures were frequent and average brush yields low. Castor bean and flax data are too few to merit discussion.

TILLAGE AND SEQUENCE RESULTS

WINTER WHEAT

Tillage Results

Winter wheat yields (fig. 7) were higher on plots that were tilled as soon as practicable after harvest than on comparable plots where tillage began shortly before seeding. They were somewhat higher where tillage loosened all the soil to a depth of about 8 inches than where it affected a shallower layer or loosened only a part of the tilled layer.

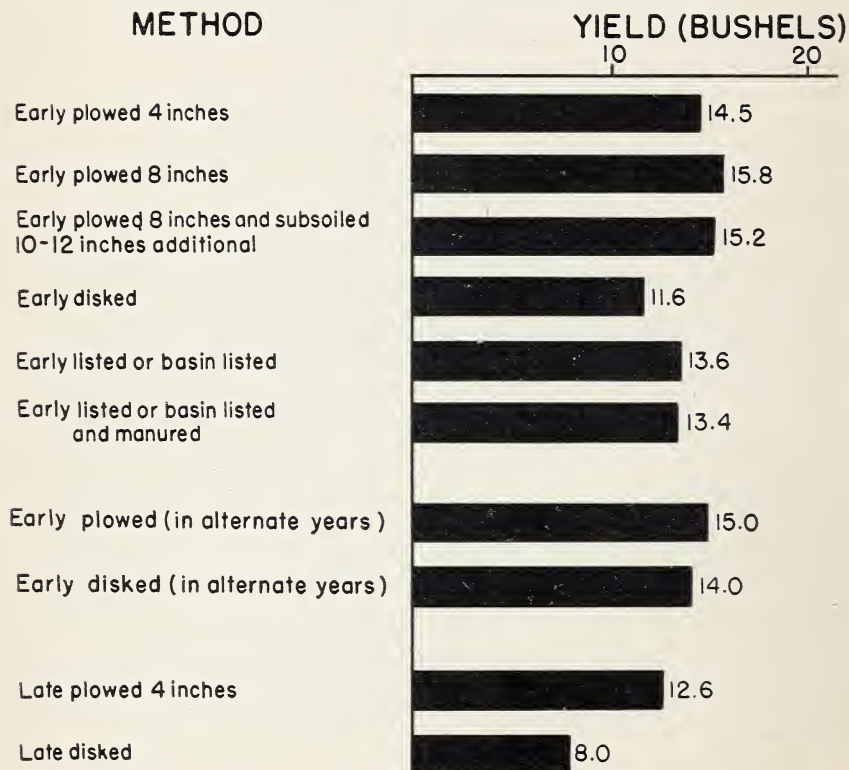


FIGURE 7.—Average acre winter wheat yields obtained with various kinds of seedbed preparation at the Lawton Field Station in 1924-49. Early tillage was performed as soon after harvest as practicable; late tillage began shortly before seeding. The plowed and subsoiled plot was thus tilled for 2 consecutive years, then was plowed only for 2 years. The plots disked in alternate years were the same that were plowed in alternate years.

A plot disked early in each year produced an average wheat yield far lower than that of any other early tilled plot and 4 bushels per acre lower than that of a plot early plowed to a depth of 8 inches. On two plots on which early disking and early plowing were practiced in alternate years, slightly smaller average yields were produced after disking than after plowing.

Subsoiling, which followed 8-inch plowing on 1 plot in alternate pairs of years and loosened the soil to an additional depth of 10 to 12 inches, did not lead to a higher yield of wheat than plowing to normal depth only; if there was a measurable difference, it was unfavorable to subsoiling. The subsoiled plot's average acre yield in the 14 years in which it was thus tilled failed by 1 bushel to match that of a plot on which 8-inch plowing only was practiced every year. Its average acre yield in the 12 years in which 8-inch plowing was practiced at a 1- or 2-year interval after subsoiling was 0.2 bushel lower than that of the continuously plowed plot. Evidently there is no immediate or residual benefit to wheat from subsoiling.

The two winter wheat plots that were listed produced somewhat lower yields than those that were plowed. The 26-year averages of wheat yield for these plots do not indicate that the manure applied to one of them gave any benefit. The detailed data (table 22, appendix) indicate, however, that eventually it did. During the first half of the 26-year period, wheat yields on the manured listed plot were lower than those on the unmanured one in 8 of the 13 years and averaged 1.7 bushels per acre lower; but during the second 13 years, the manured plot produced the lower yield only 4 times and its average acre yield was the higher by 1.1 bushels. Evidently its soil had reached a condition in which manure was helpful rather than harmful to grain yields. Straw yields were higher on the manured land throughout the experiment. The yield trends of the two plots were not regular, but the relation of the yield curves underwent a gradual change that is not wholly obscured by seasonal difference (fig. 8).

Results from the wheat studies indicate that timeliness of tillage has a great influence on yield.

Weed control during the period between harvest and seeding probably is the chief benefit from tillage commencing soon after harvest, but there is some evidence that the loosening of the soil to a depth of several inches may be beneficial, also. In this case most of the tests were made with the plow, but it is believed that any other implement loosening the soil to the same depth and controlling weeds equally well would be equally effective.

Results of tillage tests with wheat are given in detail in table 22, appendix.

Sequence Results

Wheat was grown in combination with cotton, small grains, cowpeas, and fallow in a number of 2-year and 3-year rotations. Barnyard manure and cowpea green manure were used in some wheat rotations.

Wheat was less productive after cotton than after small grain, but manuring the cotton land eliminated most of the difference (table 3).

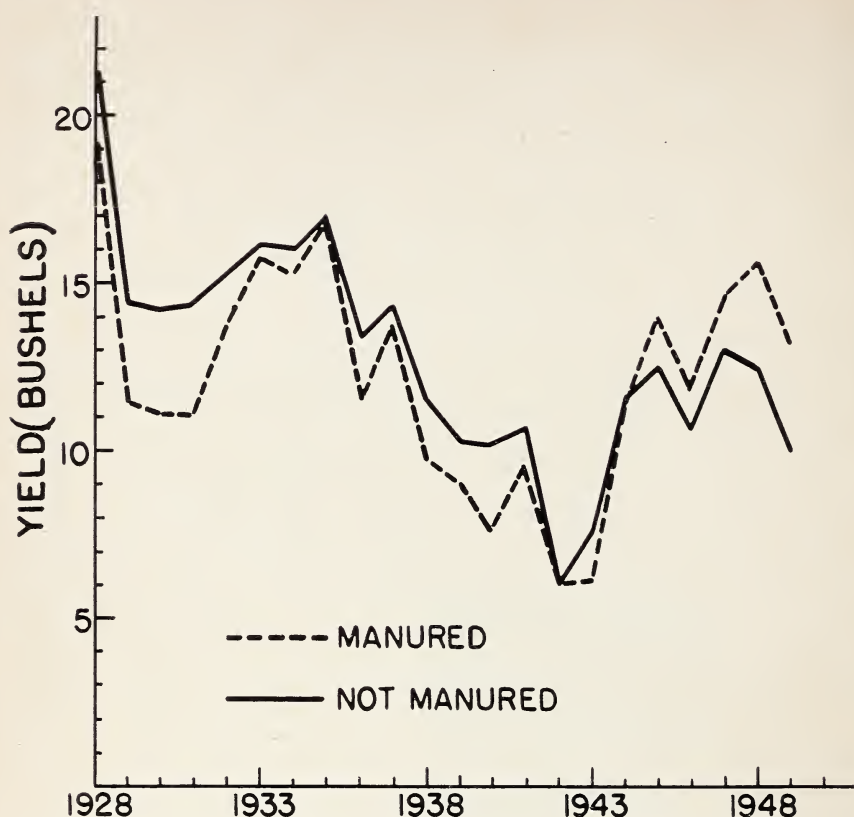


FIGURE 8.—Five-year moving yield averages of manured and unmanured continuous wheat at Lawton, Okla., 1924-49. The value charted for each year is the average annual acre yield for the 5-year period ending with that year.

Wheat after cowpeas removed as hay was approximately equal in yield to wheat after small grain. Manured wheat after cowpeas removed as hay was about equal in yield to wheat after cowpeas plowed under.

Wheat produced its highest yields on fallow. On unmanured fallow it produced an average grain yield more than a bushel to the acre higher than that on cowpea green manure, although the straw yields were nearly the same. On manured fallow it produced 2 bushels per acre more grain than on unmanured fallow, and 500 pounds per acre more straw.

The high yield on fallowed land does not mean that fallowing is profitable as a general practice in growing wheat in southwestern Oklahoma. A given acreage of land cropped continuously to wheat by good production methods will produce, on an average, about 6 bushels more of grain to the acre annually than the same acreage half in fallow and half in wheat on fallow. Fallowing may justifiably be practiced in the area as a preparation for wheat in order to

TABLE 3.—*Yields of winter wheat grown in different sequences by different cropping methods at Lawton, Okla., 1924-49*

Preceding crop, and cropping practice	Plots	Average acre yield	
		Grain	Straw ¹
Cotton:	<i>Number</i>	<i>Bushels</i>	<i>Pounds</i>
Stubble in.....	5	13. 4	1, 441
Stubble in and manured.....	2	15. 1	1, 610
Small grain, early plowed.....	5	15. 7	1, 754
Cowpea hay:			
Disked.....	3	15. 9	1, 657
Disked and manured.....	1	18. 0	1, 952
Cowpeas, plowed under.....	2	18. 1	1, 989
Summer fallow:			
Not manured.....	1	19. 4	1, 993
Manured.....	2	21. 7	2, 514

¹ Not harvested after 1946.

produce seed free from mixtures (fig. 9), under special conditions such as after failure of a wheat crop, or sometimes when wheat is to follow sorghum. Although wheat was not grown in rotation with sorghum in these studies, because of chinch bugs, it is known that yields of wheat are materially lower after sorghum than after cotton.

Green manuring with cowpeas cost more than fallowing and contributed less to grain yield of wheat. It could be justified only if it maintained the productive capacity of the soil at a level higher than that of soil on which wheat is grown each year. Results presented later under the heading "Nitrogen Content of Cropped Soil" do not indicate that it does this.



FIGURE 9.—Winter wheat growing on fallowed land at the Lawton Field Station, in a variety test. Fallowing, unprofitable as a general practice, is justified under special conditions such as need to prevent seed mixtures.

The suitability of other crops for rotation with wheat depends on their own value and on how their yields are affected by wheat, as well as on their effect on wheat. Thus the relatively low yield of wheat after cotton does not necessarily mean that wheat should not be grown in that sequence. It does indicate that the value of a cotton crop preceding wheat must be enough greater than that of a competing crop to compensate any reduction the cotton will cause in the wheat yield.

Results of rotation tests with wheat are given in detail in table 23, appendix.

COTTON

Cotton yields obtained with different types of tillage and different rotations are presented in terms of weight of seed cotton, or total weight of lint and seed. Weight of seed cotton is as reliable a means of comparing treatments as the separate weights of lint and seed would be. The average proportion of lint varied from year to year (table 2), but differences in lint percentage in a given year according to treatment were so small that measuring the lint for each treatment probably would have resulted in a greater error than computing a percentage for the whole crop and assigning this percentage to each treatment.

Tillage Results

The cotton yields in 1917-31 for the seven cropping methods then in use (table 4) show a superiority of winter over spring plowing, a possibility of additional benefit from subsoiling, lack of a material response to summer fallowing, and a very much lower yield from land listed in the winter or spring and lister planted than from plowed land. Land winter plowed and lister planted produced cotton yields not much below those on land winter plowed and surface planted. seems certain that the low yields on land that was listed instead of being plowed were due to failure to loosen the soil deeply well in advance of planting.

Because of the unexpectedly poor cotton yields from listed land in 1917-31, the lister treatments were tested again, in duplicate, with others for comparison, on another piece of land in 1933-49. Results from the second test (table 4) confirm, in the main, those of the first. Winter-listed and lister-planted land produced cotton yields more than 200 pounds to the acre below those on winter-plowed and lister-planted land. Delaying the initial listing until spring and then lister planting led to a slightly lower yield. Results from the second test do not indicate any benefit from subsoiling.

Results of tillage tests with cotton are given in detail in table 24, appendix.

Sequence Results

Cotton yields on fall-plowed cotton, sweetclover, corn, sorgho, and feterita land in field A were substantially the same (table 5). The yield on fall-plowed cowpea stubble exceeded the others materially, but how much of the difference was due to the previous crop and how much to manure in the rotation is a question. The lowest of the

TABLE 4.—*Yields of cotton grown continuously by different tillage methods and alternated with fallow in 1917-31 and comparable yields of cotton grown on other plots in 1933-49 at Lawton, Okla.*

Cropping method	Average acre yield of seed cotton		
	1917-31	1933-49	
		On duplicate plots ¹	Average
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Continuous methods:			
Spring plowed, surface planted.....	601		
Winter plowed, surface planted.....	655		
Winter plowed and subsoiled, surface planted.....	671	{ 569 628 }	599
Winter listed, lister planted.....	485	{ 381 412 }	397
Spring listed, lister planted.....	425	{ 366 385 }	376
Winter plowed, lister planted.....	629	{ 622 604 }	613
Alternately cropped and fallowed.....	678		

¹ None of these had been used in 1917-31.

cotton yields in field A was that produced on disked cowpea stubble. This result does not indicate the influence of cowpeas on subsequent cotton yields; like results in the tillage tests, it indicates the necessity of loosening the soil mass deeply before planting cotton.

Cotton yield was a little lower on spring-plowed corn ground than on fall-plowed corn ground—in spite of the fact that the rotation in which the spring plowing occurred contained alfalfa, which would be expected to provide a better state of fertility. This difference between results on spring-plowed and fall-plowed ground corresponds to results in the tillage tests.

In field B, under comparable conditions cotton after wheat produced slightly higher average yields than cotton after cotton. In both 3-year rotations of wheat, cotton, cotton, the cotton immediately following wheat was slightly more productive than the second cotton crop.

Although tillage variables prevent exact comparisons, it seems evident that cowpeas were superior to wheat as a preparation for cotton. There is evidence that the same thing was true of oats. Yield of cotton averaged much lower after barley than after wheat, for some unknown reason. Yield of cotton after wheat on spring-plowed land equaled that on comparable fall-plowed land. This was one of few instances at Lawton in which yield after spring plowing equaled yield after fall plowing.

Cotton yields on green-manured and on fallowed land were higher than those on land where a crop had been grown and harvested in the preceding year, but not enough higher to compensate the lack of a year's harvest.

TABLE 5.—*Yields of cotton grown in different sequences by different cropping methods at Lawton, Okla., 1924-49*

FIELD A

Preceding crop, and manuring treatment	Average acre yield of seed cotton, by cropping method		
	Fall or winter plowed	Spring plowed	Disked, fallowed, or green manured
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cotton.....	675		
Sweetclover.....	663		
Corn.....	673	¹ 641	
Sorgo.....	691		
Feterita.....	689		
Cowpeas.....			² 598
Cowpeas, manure in rotation.....	764		

FIELD B

Wheat.....	550	576	
Wheat, manure or green manure in rotation.....	591		
Cotton.....	524		
Cotton, manure in rotation.....	572		
Cowpeas.....		619	
Cowpeas, manure in rotation.....		635	
Cowpeas, plowed under.....			666
Barley.....	503		
Oats.....	618		
Peanuts or Mung beans ³		597	
Rye, plowed under.....			720
Fallow.....			690
Fallow, manured.....			799
Fallow (cotton topdressed).....			706

¹ The rotation included alfalfa.² Disked.³ Peanuts in 1924-42, Mung beans in 1943-49.

In comparable rotations with and without manure, the higher cotton yields were produced on manured land. A difference in cotton yield was associated with difference in time of application of manure in the fallow rotations. Applying the manure when the land is being fallowed evidently results in much greater benefit than applying it as a topdressing after the cotton is planted.

Results of rotation tests with cotton are given in detail in table 25, appendix.

SORGHUMS

Tillage Results

Kafir, feterita, and sorgo yields (table 6) were higher on land that had been fall or winter plowed than on land that had been spring

plowed, where no soil amendment was involved. The stover yields on land that had been fall or winter plowed and subsoiled were higher than those on land that had been fall or winter plowed only, but certainly not enough higher to compensate the cost of subsoiling.

Kafir that was lister planted produced materially smaller yields of grain than kafir grown on spring-plowed land, but it did not produce smaller yields of stover.

Kafir and sorgho grew much more vigorously on plots that were manured in advance of spring plowing than on unmanured spring-plowed land. The greater growth resulted in greater yield of stover, but not in a materially greater yield of grain. In many years, the manured sorghum plots fired severely earlier than the others.

TABLE 6.—*Yields of kafir, feterita, and sorgho grown continuously by different cropping methods and alternated with fallow at Lawton, Okla., 1924-49*

Cropping method	Average acre yield				
	Kafir		Feterita		Sorgho
	Grain	Stover	Grain	Stover	
Continuous methods:	<i>Bushels</i>	<i>Pounds</i>	<i>Bushels</i>	<i>Pounds</i>	<i>Pounds</i>
Spring plowed	14. 3	2, 900	12. 4	2, 294	4, 719
Spring plowed and manured	14. 5	4, 176	-----	-----	8, 666
Fall or winter plowed	16. 2	3, 109	13. 8	2, 531	4, 927
Fall or winter plowed and subsoiled	16. 6	3, 425	-----	-----	5, 978
Lister planted	11. 5	2, 962	-----	-----	5, 266
Alternately cropped and fallowed	19. 2	4, 019	15. 9	2, 988	6, 777

Fallowing led to the highest yields of kafir and feterita and the second-highest yield of sorgho, but none of the yields on fallowed land were enough higher than those on plowed land to justify the sacrifice of a year's crop.

Because of the low yields of kafir on listed land in the early years, tests were made to determine whether some variant of lister preparation would give materially better results than others. The eight methods tested varied as to time of beginning preparation, tillage after listing, and whether the kafir was planted in the original furrows or by splitting ridges. No tillage variant increased kafir yield above the level attained on listed plots in the original tillage experiments; a cropping variant including a winter application of manure, however, led to a grain yield greater by more than 2 bushels to the acre and a stover yield about 800 pounds to the acre greater than that produced by a comparable listed plot not receiving manure.

Results of tillage tests with sorghum are given in detail in tables 26, 27, and 28, appendix.

Sequence Results

Yields of kafir and feterita (table 7) did not vary greatly according to the preceding crop. The yield of kafir was not markedly increased by fallowing. The yield of feterita on green-manured land was 3 bushels to the acre above that on fall plowing after harvested cowpeas—an increase much too small to justify the sacrifice of a harvest.

The tillage results for both kafir and feterita in rotations agreed fairly well with those obtained in the regular tillage experiments. Fall or winter plowing led to greater yields than spring plowing. Kafir produced its lowest grain yield in the one rotation in which it was planted with a lister. The lister-planted kafir produced a relatively good stover yield, perhaps because of sweetclover in the rotation.

Kafir on manured kafir land produced a lower grain yield but a slightly higher stover yield than that on comparable unmanured land. The lower average of grain yield on manured land in this instance was due chiefly to the crop of a single year, 1941. In that year early injury on manured land drastically reduced yield even though the season later became very favorable.

Results of rotation studies with sorghum are given in detail in tables 28 and 29, appendix.

TABLE 7.—Yields of kafir and feterita grown in different sequences by different cropping methods at Lawton, Okla., 1924-49

Crop, preceding crop, and manuring treatment	Average acre yield, by cropping method							
	Spring plowed		Fall or winter plowed		Listed		Fallowed or green manured	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
Kafir:	<i>Bushels</i>	<i>Pounds</i>	<i>Bushels</i>	<i>Pounds</i>	<i>Bushels</i>	<i>Pounds</i>	<i>Bushels</i>	<i>Pounds</i>
Kafir.....	12. 8	2, 830	15. 6	3, 382	-----	-----	-----	-----
Kafir, manured.....	-----	-----	14. 0	3, 538	-----	-----	-----	-----
Feterita.....	13. 0	3, 109	15. 0	3, 191	-----	-----	-----	-----
Cotton.....	13. 3	3, 056	-----	-----	-----	-----	-----	-----
Cotton, sweet-clover in rotation.....	-----	-----	-----	-----	12. 2	3, 472	-----	-----
Cowpeas.....	14. 0	3, 089	15. 5	3, 534	-----	-----	-----	-----
Oats, manured.....	-----	-----	16. 1	3, 556	-----	-----	-----	-----
Fallow.....	-----	-----	-----	-----	-----	-----	15. 3	3, 340
Feterita:								
Kafir.....	10. 9	2, 490	13. 3	2, 696	-----	-----	-----	-----
Cowpeas.....	11. 5	2, 425	15. 1	3, 042	-----	-----	-----	-----
Cowpeas, plowed under.....	-----	-----	-----	-----	-----	-----	18. 1	3, 218
Cotton.....	9. 9	2, 397	-----	-----	-----	-----	-----	-----

COWPEAS

Results with cowpeas (table 8) emphasize the superiority of fall over spring plowing. Manure applied to another crop in the rotation increased cowpea hay production slightly. There appeared to be some residual benefit from sweetclover, also.

TABLE 8.—*Hay yields of cowpeas grown in different sequences by different cropping methods at Lawton, Okla., 1924-49*

Field, preceding crop, and manuring treatment	Average acre hay yield, by tillage method	
	Spring plowed	Fall or winter plowed
Field A:	<i>Pounds</i>	<i>Pounds</i>
Kafir.....	1, 976	2, 241
Kafir, manured.....		2, 629
Feterita.....	1, 965	2, 127
Cotton, sweetclover in rotation.....		2, 443
Field B:		
Wheat.....	1, 917	
Cotton.....	1, 961	2, 066
Cotton, manure in rotation.....	2, 140	

CORN

Some results of the corn tillage experiments (table 9) contrast strikingly with results of experiments with other crops. No evidence appeared of superiority of fall plowing over spring plowing. Instead of a lower yield, lister planting without plowing led to a distinctly higher yield of grain. These differences may be explained by the fact that corn is more subject to firing from drought than most of the crops tested and often is actually benefited by the reduction of early growth resulting from listing. This has been observed not only at Lawton but also at other stations in the southern Great Plains.

A result that has not been observed at other Great Plains stations is the response of corn to subsoiling. Yields following subsoiling were consistently high, averaging higher than those on fallow. This is the most substantial benefit to a crop from subsoiling that has been noted in the Great Plains.

Yields on fallow land were much greater than those following spring or fall plowing where manure had not been used, but averaged little greater than those following listing. Fallowing cannot be recommended for corn production.

The most striking result is the increasing response of the corn crop to manure (fig. 10). There was always some response to manure, but the yield difference between unmanured and manured land appeared to increase gradually. After the middle twenties, corn grain yields on unmanured land were maintained or increased but stover yields suffered a gradual decline. On manured land both grain and stover yields increased during the same period and grain yields from 1941 onward exceeded those obtained when the land was first cropped.

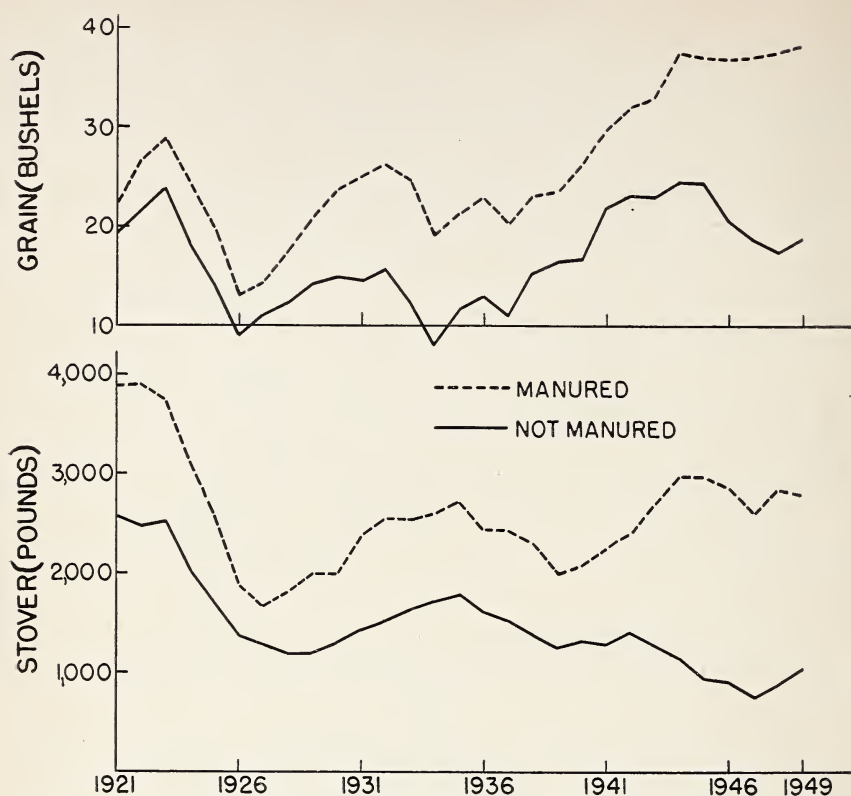


FIGURE 10.—Five-year moving averages of corn grain and stover yields per acre on manured and unmanured plots at Lawton, Okla.

TABLE 9.—Yields of corn grown in different sequences by different cropping methods at Lawton, Okla., 1924-49

Preceding crop, and cropping method	Average acre yield	
	Grain	Stover
Corn:	<i>Bushels</i>	<i>Pounds</i>
Spring plowed.....	16. 1	1, 253
Spring plowed, corn topdressed.....	27. 4	2, 438
Fall or winter plowed.....	16. 2	1, 280
Fall or winter plowed and subsoiled.....	23. 6	1, 721
Lister planted.....	19. 6	1, 376
Early cultivated, lister planted.....	21. 9	1, 570
Oats, spring plowed ¹	15. 1	1, 660
Sorgo, fall or winter plowed.....	13. 6	1, 510
Fallow.....	21. 9	1, 652

¹ Alfalfa in rotation.

Grain yields of corn in certain late years of the experimental period, particularly on manured land, were more reliable than grain yields of sorghums. This result is in sharp contrast with early experience at the station. It does not indicate that corn should replace sorghums in southwestern Oklahoma, for the crop is still plagued in the area by poor quality of both the grain and the stover. It does indicate that soil conditions are more of a factor in corn yield than had been recognized, and that proper fertilizing and adequate protection from insects can result in higher yields of corn.

Results of tillage and rotation experiments with corn are given in detail in table 30, appendix.

OATS AND BARLEY

Oats were not tested adequately in the rotation experiments, partly because it was believed that their responses to tillage methods would be much the same as those of wheat and partly because their value for pasture could not be measured in these experiments. Five plots of spring oats were grown in the two fields.

Yield of oats (table 10) was higher on wheat land that had been fall-plowed than on wheat land that had been disked. It was higher on disked cotton land than on disked wheat or fall-plowed alfalfa land.

Barley, like oats, was not represented adequately in the rotation experiments, for the same reasons. Only 2 plots of spring barley and 1 of winter barley were grown. The only cultural comparison that could be made was that between disked cowpeas and disked wheat as preparation for barley. Any difference due to sequence was obscured by differential damage by insects.

TABLE 10.—*Yields of spring oats grown in different sequences by different tillage methods at Lawton, Okla., 1924-49*

Field, and preceding crop	Average acre yield, by tillage method	
	Fall or winter plowed	Disked
Field A:	<i>Bushels</i>	<i>Bushels</i>
Alfalfa	28. 1	-----
Cotton	30. 2	-----
Field B:		
Wheat	28. 7	26. 6
Cotton	-----	30. 7

ALFALFA AND SWEETCLOVER

For alfalfa and sweetclover, sequence variables were not adequate to permit many comparisons. It was evident, however, that yields of oats and cotton, the crops immediately following these legumes in

rotations. were not benefited by them. The stover or hay yields of crops that followed the legumes but did not follow them directly appear to have been increased slightly by their residual effects.

DATE-OF-SEEDING AND VARIETY TESTS OF WINTER BARLEY

Date-of-seeding tests with winter barley were carried on for a period of 10 years. Seedings were scheduled for 10-day intervals from September 15 to November 15. The data do not permit an exact comparison of the different specified seeding dates, because in each of the 10 years the vagaries of weather and soil conditions prevented seeding at 1 or 2 of those dates. In order to make a rough comparison, the yield figures for all the dates in a year when seedings were made were averaged and the average was ascribed to the date or dates when seedings could not be made. By this method of calculation, the following 10-year averages of yield were obtained:

<i>Seeding date</i>	<i>Acre yield Bushels</i>
September 15.....	19.4
September 25.....	19.5
October 5.....	19.3
October 15.....	18.0
October 25.....	17.8
November 1.....	17.3
November 15.....	15.6

Yield in relation to planting date varied widely among individual years. Late seeding gave much poorer yields than early seeding in a few years, but gave better yields in some. Over the 10-year period, yields obtained by seeding on different dates of the period September 15–October 5 averaged about the same.

Greater amounts of fall forage were produced by early seedings. Apparently the greatest value of the crop can be obtained by planting before the middle of October.

Variety tests of winter barley were made at Lawton during the 24-year period 1925–48. The results (table 11) indicate that some of the newer varieties have capacities for yield materially above that of the check variety, Wisconsin 519.

The acreage of winter barley in Oklahoma declined greatly during the period 1939–47, mainly because of winterkilling and insect pests such as greenbugs and chinch bugs. Certain new varieties that combine good cold resistance with good yielding ability promise to reduce losses from winterkilling. Improved insecticides, and varieties that have some natural resistance to greenbugs, give rise to the hope that insect damage, also, can be greatly reduced. The unquestioned value of winter barley for fall grazing, winter cover, and feed makes it an attractive and desirable crop for many farmers in southwestern Oklahoma.

TABLE 11.—Yields of winter barley in variety tests at Lawton, Okla., 1925-48

Variety	C. I. No.	Annual acre yields ¹													Average in terms of Wis- consin 519 average for same years	Percent			
		1926	1927	1928	1929	1931	1932	1933	1936	1937	1939	1940	1941	1942			1943	1944	1945
Wisconsin	519	Bu. 32.5	Bu. 27.1	Bu. 13.5	Bu. 16.6	Bu. 50.4	Bu. 51.2	Bu. 6.0	Bu. 12.0	Bu. 54.6	Bu. 13.8	Bu. 16.7	Bu. 43.7	Bu. 3.2	Bu. 19.8	Bu. 66.5	Bu. 41.4	Bu. 46.0	Bu. 25.8
Tennessee	3,546	Bu. 34.4	Bu. 30.8	Bu. 7.6	Bu. 17.8	Bu. 56.7	Bu. 44.5	Bu. 4.8	Bu. 13.4	Bu. 49.7	Bu. 17.0	Bu. 16.9	Bu. 32.1	Bu. 4.2	Bu. 23.0	Bu. 64.5	Bu. 42.1	Bu. 24.2	Bu. 98
Haus River	206	Bu. 38.8	Bu. 34.4	Bu. 8.5	Bu. 14.0	Bu. 52.4	Bu. 45.6	Bu. 6.8	Bu. 11.2	Bu. 49.6	Bu. 15.1	Bu. 16.2	Bu. 37.0	Bu. 10.6	Bu. 25.0	Bu. 66.5	Bu. 42.2	Bu. 24.9	Bu. 101
Pedar	901	Bu. 37.0	Bu. 36.5	Bu. 7.8	Bu. 12.8	Bu. 51.4	Bu. 43.9	Bu. 7.9	Bu. 11.2	Bu. 49.6	Bu. 15.1	Bu. 16.2	Bu. 37.0	Bu. 10.6	Bu. 25.0	Bu. 66.5	Bu. 42.2	Bu. 21.9	Bu. 100
Orel	351	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Michigan	2,036	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Missouri Early Beardless	6,051	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Esaw	4,690	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Wintex	6,127	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Harlan Hybrid (Texas)	6,499	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Harlan Hybrid	6,500	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Reno	6,561	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Tenkow	6,466	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Davidson	6,373	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Woodwin	7,033	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Ward	6,007	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5
Fayette	245	Bu. 39.0	Bu. 34.9	Bu. 0	Bu. 19.0	Bu. 36.7	Bu. 0	Bu. 0	Bu. 10.2	Bu. 51.1	Bu. 15.0	Bu. 20.8	Bu. 34.3	Bu. 8.2	Bu. 25.8	Bu. 52.6	Bu. 51.1	Bu. 53.3	Bu. 18.5

¹ The crop winterkilled in 1925, 1930, and 1935. These years are represented in the averages. Four years are not represented in the averages, for these reasons: 1934, not seeded; 1935, destroyed by hail; 1946, destroyed by greasiness; 1948, uneven losses caused by plant diseases.

COMPARISON OF FALL-SOWN AND SPRING-SOWN OATS

Hardy varieties of winter oats, which have come into prominence in recent years, were grown on the Lawton station in 5-year variety tests (27) in which they were compared with spring-sown varieties.

Yield of spring oats in this 5-year test (table 12) averaged about the same as in the rotations over the 26-year period. The proportion of loss of the spring oats crop, 2 crops in 5, was somewhat greater than in the rotation tests. Invariably, the fall-sown oats produced much greater yields than the spring-sown oats.

In farming systems for southwestern Oklahoma that include live-stock production, fall-sown oats can be used to great advantage for both pasture and grain.

TABLE 12.—*Grain yields of fall-sown and spring-sown oats in a 5-year comparative test at Lawton, Okla., 1943-47*

Time of seeding	Annual acre yields ¹					
	1943	1944	1945	1946	1947	Average
Fall-----	<i>Bushels</i> 35. 4	<i>Bushels</i> 79. 0	<i>Bushels</i> 88. 9	<i>Bushels</i> 85. 9	<i>Bushels</i> 87. 8	<i>Bushels</i> 75. 4
Spring-----	(²)	44. 8	37. 0	(³)	51. 4	28. 6

¹ Values are averages for the 3 highest yielding varieties.

² Crop destroyed by spring freeze.

³ Crop destroyed by greenbugs.

NITROGEN CONTENT OF CROPPED SOIL

Soil samples from plots that had been subjected to different cropping treatments were collected and analyzed in 1947. Since samples had not been taken on the plots when the experimental work was started, the only available measure of the extent of change was comparison with the virgin soil of a nearby area. The results of such comparison, combined by treatment groups, are presented in table 13.

Reduction of nitrogen content of the 0-to-6-inch layer of soil, as measured, was tremendous, ranging from 42 to 62 percent. Even under continuous small grain, usually one of the cropping practices least exhaustive of soil nitrogen, the indicated losses averaged about 45 percent. Under continuous row crops, or row crops alternating with fallow, they averaged about 60 percent.

Manure, which was very effective in increasing yields of most crops, was not effective in maintaining the nitrogen content of the soil. (Some evidence is presented in the following section, however, that it helped maintain the phosphorus content.)

Plowing under a crop of cowpeas every other year did not reduce the loss of nitrogen in the 0-to-6-inch layer of soil measurably below that incurred when the cowpeas were removed as hay.

Losses of nitrogen took place in the 6-to-12-inch layer of soil, but they were much smaller than those in the surface layer. Although the virgin soil contained about 50 percent more nitrogen in the surface

TABLE 13.—*Nitrogen content of cropped soil at the Lawton Field Station in 1947 and its percentage change in 25 to 32 years under various cropping methods*

Cropping method	Year started	Plots	Average nitrogen content at depth of—			
			0 to 6 inches		6 to 12 inches	
			1947	Change ¹	1947	Change ¹
Continuous small grains, plowed or basin listed.	1923 ²	Number 6	Percent 0.082	Percent -47**	Percent 0.085	Percent -17**
Continuous small grains, alternately plowed and disked.	1923	4	.082	-47**	.083	-1.**
Continuous small grains, disked.	1923	2	.088	-43**	.088	-1.
Continuous small grains, basin listed, manured.	1923	1	.081	-47**	.084	-18*
Alternate small grains and fallow.	1919	1	.078	-49**	.078	-24*
Alternate small grains and fallow, manured.	1919	2	.085	-45**	.080	-22*
Continuous row crops.	1916	4	.058	-62**	.079	-23**
Alternate row crop and fallow.	1916 ²	5	.061	-60**	.081	-21**
Alternate row crop and fallow, manured.	1919	2	.064	-58**	.075	-27**
Alternate small grain and row crop.	1923	1	.081	-47**	.084	-18*
Alternate small grain and cowpeas.	1919	1	.080	-48**	.091	-12
Alternate small grain and cowpeas (plowed under).	1919	1	.082	-47**	.086	-16
Alternate small grain (topdressed) and cowpeas.	1919	1	.090	-42**	.094	-9
Virgin sod.		9	.154		.103	

¹ 1 asterisk indicates significance at the 5-percent level. 2 asterisks indicate significance at the 1-percent level. Changes were calculated on the basis of the nitrogen content, in 1947, of the virgin soil of a nearby area. No significant differences were found between changes at the 6-to-12-inch depth associated with different cropping methods. Least significant differences between changes at the 0-to-6-inch depth associated with any two cropping methods are as follows:

Level of significance (percent)	L. S. D., by numbers of plots subjected to the two treatments being compared												
	1 v. 4	1 v. 2	1 v. 4	1 v. 5	1 v. 6	2 v. 2	2 v. 4	2 v. 5	2 v. 6	4 v. 4	4 v. 5	4 v. 6	5 v. 6
5	Pct. 14	Pct. 12	Pct. 11	Pct. 11	Pct. 10	Pct. 10	Pct. 8	Pct. 8	Pct. 8	Pct. 7	Pct. 6	Pct. 6	Pct. 6
1	19	16	15	15	14	14	12	11	11	10	9	9	8

² For 1 plot, 1919.

layer than in the 6-to-12-inch layer, by 1947 the cropped soil contained slightly less nitrogen in the surface layer than in the 6-to-12-inch layer.

Measurements of carbon content of the soil were made for some but not all of the plots. Carbon-nitrogen ratio was found not to vary significantly with cropping treatment; therefore nitrogen changes can be used as a reliable measure of relative changes in the organic carbon content of the soil. The soil's carbon-nitrogen ratio was slightly lower on cropped land than on virgin land.

The results of the analyses, fragmentary as they are, certainly demonstrate that there is no easy way to maintain the nitrogen and organic carbon of soils under conditions such as those at Lawton. Building up the organic-matter content of the soil by any practicable means appears to be difficult if not impossible.

The physical condition of the soil seemed to have changed for the worse during the time that the area had been under cultivation. This was evidenced by increased difficulty in performing cultural operations and by increased runoff during torrential summer rains. Grasses and legumes have been suggested as means of building up the soil, but it seems highly probable that their chief benefit is in

bettering its physical condition and in preventing further soil and fertility losses during the time that they occupy the land.

TESTS WITH COMMERCIAL FERTILIZERS

The heavy losses in nitrogen and carbon revealed by the 1947 analyses made it appear likely that the soil had reached such a condition that fertility rather than moisture was limiting crop yields. The generally good results from manure, and spectacular increases in grass-seed yields associated with nitrogen applications in a 1946-47 experiment, made it appear likely that nitrogen was the chief limiting factor. Experiments were conducted in 1948 and 1949 to determine the responses of major field crops to fertilizer. These were too brief to furnish any reliable measure of the average increases that might be attained through fertilizers, but they did furnish some important information.

SEED YIELDS OF WEEPING LOVEGRASS

Nitrogen in the form of ammonium nitrate was applied at different rates in 1946 and 1947 to a stand of weeping lovegrass (*Eragrostis curvula*) established in 1944. As little as 30 pounds of nitrogen to the acre produced spectacular increases in seed yields, averaging 119 pounds to the acre in 1946 and 301 pounds to the acre in 1947 (fig. 11).

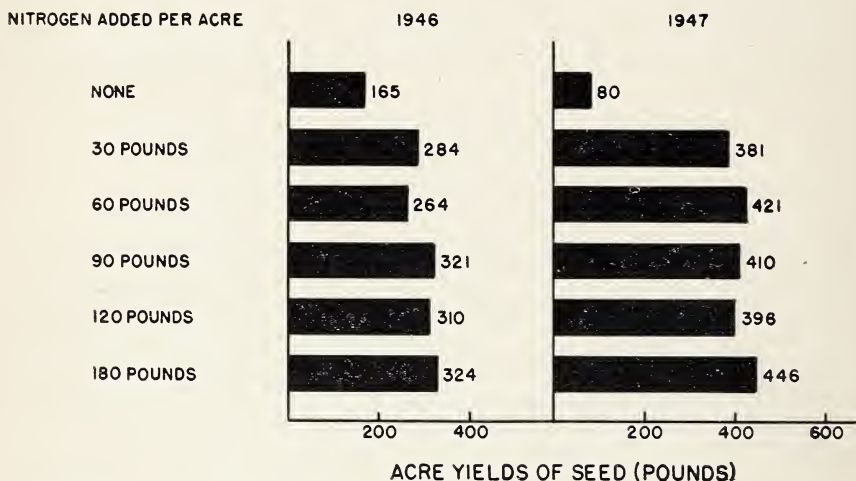


FIGURE 11.—Seed yields of weeping lovegrass on soil variously treated with nitrogen at Lawton, Okla.

Additional quantities of nitrogen produced only small further increases in yield.

Hay yields of weeping lovegrass were not determined, but a material increase in vegetative growth was observed where nitrogen had been applied. It was further observed that work mules ate the hay from the fertilized land readily although they refused that from the unfertilized land.

SORGHUM

An experiment on kafir was conducted in 1948 to determine (1) what effect application of nitrogen had on kafir grain and fodder yields and (2) whether delayed application of nitrogen would benefit the crop without producing the stimulation of early growth that had often resulted in severe firing of manured plots. A few phosphorus treatments were included to obtain evidence on whether phosphorus might be deficient.

The experiment was conducted on land that had been in kafir for more than 30 years and had probably lost at least 60 percent of its original nitrogen. The results (table 14) were as positive as they were surprising. No benefit whatever resulted from applying nitrogen, regardless of quantity or time of application; the plots receiving nitrogen alone were not observably different from the checks. On all the plots receiving phosphorus, the kafir produced materially greater yields and ripened at least a week earlier than on the check plots. Nitrogen in addition to phosphorus did not increase yields significantly.

This experiment made it appear that, at least as far as sorghums were concerned, response to manure was chiefly a response to its phosphorus rather than to its nitrogen content. This was confirmed by a single replication of the experiment on land that had been in manured kafir for more than 30 years. On this manured land, kafir showed no response to application of either nitrogen or phosphorus.

In 1949 a test was made of the effects of applications of phosphorus with and without nitrogen on kafirita. Phosphorus was applied at the per-acre rates of 25, 50, and 100 pounds of P_2O_5 , and nitrogen at that of 30 pounds. There was one delayed application of nitrogen. At no time during the season was there an observable difference between

TABLE 14.—*Yields of kafir on soil variously treated with commercial fertilizers at Lawton, Okla., 1948*

Fertilizer applied per acre and time of application	Acre yields	
	Grain	Stover
	<i>Bushels</i>	<i>Pounds</i>
No fertilizer.....	14. 8	4, 000
30 pounds N:		
At seeding.....	14. 2	3, 940
4 weeks after seeding.....	8. 8	3, 100
6 weeks after seeding.....	14. 7	3, 980
8 weeks after seeding.....	11. 2	3, 930
60 pounds N, 6 weeks after seeding.....	11. 8	3, 540
100 pounds P_2O_5 , at seeding.....	19. 6	4, 970
100 pounds P_2O_5 and 30 pounds N, at seeding.....	20. 6	4, 540
100 pounds P_2O_5 , at seeding; 60 pounds N, 6 weeks after seeding.....	20. 5	4, 560
L. S. D. at 5-percent level.....	3. 8	490

the plots to which nitrogen had been applied and the other plots. Early growth and vigor of the crop varied in direct proportion to the quantity of phosphorus applied. On plots receiving P_2O_5 at the 25-pound rate kafir showed only slightly greater early vigor; on those receiving it at the 50-pound rate kafir was markedly more vigorous; and on those receiving it at the 100-pound rate, kafir showed outstanding vigor comparable to that on the manured plots. For a time the plots that had received the 100-pound P_2O_5 treatment appeared to be capable of producing yields more than double those on plots that had received little or no phosphorus. Protracted drought during July and August checked the vegetative growth on all plots and reduced grain yields to near failures. The vigorous kafir that had made the most growth suffered first. The final yields did not differ significantly according to treatment, either in weight of grain or in total weight. This experiment demonstrated that the soil was seriously deficient in phosphorus, and also demonstrated that fertility differences did not result in yield differences when moisture was deficient.

Within the period of operation of the Lawton Field Station, apparently, the proportion of phosphorus in the soil of plots cropped continuously to sorghums dropped from an original average of about 260 parts per million to about 180.⁵ This reduction, which is greater than that in soil cropped to small grains or in soil cropped to small grains and row crops in rotations, is evidently enough to make phosphorus a limiting factor in sorghum production. Row-crop land that was manured each year continued to contain about 210 parts per million of phosphorus.

WHEAT AND OATS

Tests of the effects of nitrogen and phosphorus treatments on yields of winter wheat and winter oats were conducted during the 1948-49 crop season, on soil in a somewhat better fertility condition than that on which the sorghum tests were made. The experiment involved both quantity of nitrogen applied and time of application. Yields obtained where nitrogen alone was applied differed little or not at all from those of the check plots (table 15). Application of phosphorus

TABLE 15.—Yields of winter wheat and winter oats on soil variously treated with commercial fertilizers at Lawton, Okla., 1949

Fertilizer application per acre			Acre yields		Fertilizer application per acre			Acre yields	
P_2O_5 , fall (pounds)	Nitrogen		Winter wheat	Winter oats	P_2O_5 , fall (pounds)	Nitrogen		Winter wheat	Winter oats
	Fall	Spring				Fall	Spring		
	Pounds	Pounds	Bushels	Bushels		Pounds	Pounds	Bushels	Bushels
0-----	0	0	13.9	54.1	30-----	0	20	17.3	63.9
	20	0	12.7	52.2		10	10	19.9	59.4
	0	20	12.0	50.8		40	0	15.4	56.8
	10	0	16.1	60.6		0	40	17.0	60.3
	0	10	17.9	60.1		10	30	17.1	63.3
30-----	20	0	16.5	56.1		0	0	17.9	61.3
L. S. D. at 5-percent level-----								1.2	2.3

⁵ Unpublished data from analyses made at the Northern Great Plains Field Station, Mandan, N. Dak.

alone increased yields as much as did applications of both nitrogen and phosphorus. The quantity or time of application of nitrogen made little difference; spring or split applications tended to give slightly better results than fall applications.

COTTON

A preliminary experiment with cotton was conducted in 1949. This involved the same phosphorus applications as the kafirita experiment and a single nitrogen treatment. The cotton did not show any observable difference in early growth or vigor according to quantity of phosphorus applied. Neither did it show any effect, beneficial or otherwise, from nitrogen. All yields were greatly reduced by drought in July and August. Yield did not vary significantly according to treatment, although it was slightly better where the fertilizer treatments had been applied.

RESULTS WITH GRAPES, TREES, SHRUBS, AND GRASSES

GRAPES

A small vineyard consisting of a few vines each of about 20 varieties was planted in 1923. A few other varieties were added later.

The Lawton silt loam soil is not well adapted to grapes, most varieties of which prefer a deep, fertile sandy or sandy loam soil. Vine growth was restricted, and in dry seasons the fruit of some of the varieties shriveled instead of ripening properly and was worthless. Commercial growing of grapes should not be attempted on soil of this type, but a few selected varieties can well be grown on it for home use.

In spite of the unsuitability of the soil, 10 varieties made average annual yields of 10 to more than 14 pounds per vine over a period of years. Some of the varieties suffered drought damage in the dry years, and some of these and others suffered from black rot in wet years. Grapes of some of the higher yielding varieties are poor in quality and satisfactory only for juice and jellies. The vineyard was heavily damaged by June bugs. A small vineyard often suffers very severe damage from birds and from insects, particularly wasps. Black rot and some of the insects can be controlled by proper spraying.

Extra is the only one of the varieties tested that can be generally recommended for home use on Lawton silt loam. Delaware made rather low yields, but a few vines of this variety might be included to extend the season with a high-quality table grape. A few vines of American, with Beacon as a pollinator, might also be included for juice and jellies. Cleota produced dependably, and its grapes were satisfactory for table use when fully vine ripened. (It is doubtful, however, that vines of this variety are now available commercially.)

Many grape varieties that did not do well in the station vineyard make creditable yields on the sandy soils of southwestern Oklahoma. On these soils, the Oklahoma Agricultural Experiment Station (2) has advised,

Extra should be the leading commercial variety, with Carman and Bailey grown on a small scale for trial as grapes that may develop into commercial varieties, and Beacon, America, Niagara, Ellen Scott, Armalage, Catawba and Last Rose grown to give a wide variety for home use and local market.

TREES AND ORNAMENTAL SHRUBS

Deciduous trees, evergreens, and hardy flowering shrubs may well be used in southwestern Oklahoma to provide beauty, comfort, and protection for the farm homestead. Appropriate plantings add much to the appearance and value of the farm and help in keeping farm boys and girls on the land.

Many trees and shrubs grown on the Lawton Field Station proved hardy and useful on ground of medium fertility, under wide variations of rainfall and in spite of droughts and destructive storms. Among the trees tested, Arizona cypress (*Cupressus arizonica*) thrived particularly well (fig. 12). Many ornamental shrubs not included in the station tests may be well adapted to the area (17).

The following tree and shrub species and varieties are recommended for planting in southwestern Oklahoma, almost entirely on the basis of their behavior in station plantings:

Deciduous trees:

- American elm (*Ulmus americana*)
- Apricot (*Prunus armeniaca*)
- Black walnut (*Juglans nigra*)
- Common hackberry (*Celtis* sp.)
- Common jujube or Chinese date (*Zizyphus jujuba*)
- Double red peach (*Prunus persica*)
- Green ash (*Fraxinus pennsylvanica lanceolata*)
- Small-leaved elm (*Ulmus parvifolia*)
- Sycamore (*Platanus occidentalis*)
- Thornless honeylocust (*Gleditsia triacanthos inermis*)



FIGURE 12.—Arizona cypress growing at the Lawton Field Station.

Evergreen trees:

- Arizona cypress (*Cupressus arizonica*)
- Cherrystone juniper (*Juniperus monosperma*)
- Colorado juniper (*Juniperus scopulorum*)
- Pfitzer juniper (*Juniperus chinensis pfitzeriana*)
- Redcedar (*Juniperus virginiana*)
- Savin juniper (*Juniperus sabina*)
- Silver juniper (*Juniperus virginiana glauca*)

Flowering shrubs and ornamentals:

- Amur privet (*Ligustrum amurense*)
- Anthony Waterer spirea (*Spiraea bumalda*)
- Crapemyrtle (*Lagerstroemia indica*)
- Desertwillow (*Chilopsis linearis*)
- Douglas spirea (*Spiraea douglasii*)
- Everblooming honeysuckle (*Lonicera heckrottii*)
- Firethorn (*Pyracantha coccinea lalandii*)
- Flame-leaf sumac (*Rhus copallina*)
- Flowering quince (*Chaenomeles lagenaria*)
- Glossy abelia (*Abelia grandiflora*)
- Kashgar tamarix (*Tamarix hispida*)
- Mockorange (*Philadelphus virginalis*)
- Nandina (*Nandina domestica*)
- Rose-of-Sharon or shrub-althea (*Hibiscus syriacus*)
- Thunberg spirea (*Spiraea thunbergii*)
- Trumpet honeysuckle (*Lonicera sempervirens*)
- Vanhoutte spirea (*Spiraea vanhouttei*)
- Vitex (*Vitex angus-castus*)
- Weeping quihoui privet (*Ligustrum quihoui pendulum*)

Planting plans must be adapted to and developed for individual farm homes. They will vary in accordance with topography, soil, and the number and kind of farm structures.

Careful planting when the soil is well filled with water, and later cultivation, are essential to the establishment of good root systems that will promote vigorous growth the first year. After the first year the chief requirements are continued elimination of competing weeds, careful pruning, and control of the few diseases and insect pests that are prevalent in the area.

GRASSES

No extensive grass experiments were carried out at the station, but because of the need for a soil-binding crop a few simple exploratory tests were made on the establishment of stands of important native grasses and recently introduced foreign grasses. Such tests were made both on the station and on a number of farms representing average farm conditions in Comanche County and several adjoining counties of southwestern Oklahoma.

Weeping lovegrass was seeded in 1944 on the station and on farms in Comanche County, on clean cultivated land. The station plantings consisted of two 1-acre blocks and a number of small plots, which were seeded at intervals from April 5 to September 15. Good stands resulted from all these seedings. In the first year the grass made good vegetative growth but produced practically no seed. Vigorous growth and satisfactory seed yields were obtained in 1945, the second year. Seed yields in 1946 and 1947 were stimulated by nitrogen fertilizer, as discussed earlier.

The farm seedings of weeping lovegrass consisted of 1- to 1½-acre blocks on 5 farms. All these seedings were made in the spring. Only one of them resulted in a satisfactory stand.

Sand lovegrass (*Eragrostis trichodes*) was seeded on the station in 1945 and 1946 in rows at 7-inch and 22-inch intervals. Good stands were obtained each year in both spacings, but negligible vegetative growth and seed production in succeeding years demonstrated emphatically that this grass is not adapted to heavy soils.

Buffalo grass sprigs were planted in 1946, spaced 2 feet apart in rows 40 inches apart. The grass demonstrated its high adaptation by completely covering the ground surface the first year.

Sowing of side-oats grama seed in 40-inch rows resulted in good stands. The grass grew vigorously and gave evidence of seed production good enough to justify harvesting for the purpose of increasing the supply of seed of desirable strains.

Failures to obtain stands of grasses through seeding on farms are believed to be due more often to covering the seed too deeply than to any other single cause. This belief led to construction of a grass-seeding drill (fig. 13). Cooperation in this project was received from the Lawton Chamber of Commerce and from H. C. Hyer, Extension Division, Oklahoma Agricultural and Mechanical College.

Seedings of a grass mixture were made on farms selected as representative of southwestern Oklahoma's soil types and topography. The mixture consisted of little bluestem, blue grama, side-oats grama, and buffalo grass. On the whole, the seedings were successful. Subsequent additional seedings made under soil conservation district direction now cover several thousand acres. Most of the seedings were on land that does not produce row crops or small grains profit-

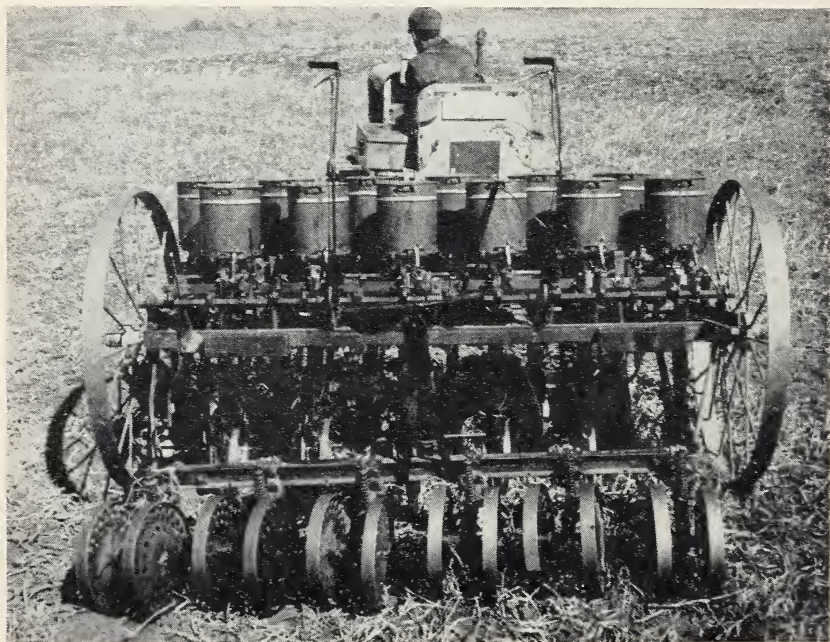


FIGURE 13.—Grass-seeding drill constructed at the Lawton station. This drill permits planting nearly all types of grass seed at a controlled uniform shallow depth and packs the soil firmly over the seed.

ably. It seems evident that the fertilizer needs of such areas must be determined and met before the areas are regrassed, if production potentialities are to be realized.

CROPPING SYSTEMS ADAPTED TO THE AREA

Out of the combination of practical farming experience and the results of research, certain principles have evolved that point the way to a profitable permanent agriculture for southwestern Oklahoma.

In mixed farming on the uplands of southwestern Oklahoma, the surest system for a regular cash income is raising livestock on home-grown feed. The first essential of such a system is to produce feed sufficient to support the maximum number of livestock through good years and bad. Crops with which this requirement can be fulfilled are grain and forage sorghums for roughages, winter oats for grazing and feed, and winter wheat and cotton for cash crops and for protein supplements. In addition, either native or reseeded grassland must be available for grazing. Legume crops such as cowpeas, Mung beans, and (on sandy soils) hairy vetch are good producers of hay rich in protein; but when harvested for hay they do nothing to improve or maintain soil productivity. Sweetclover grown in paired cultivated rows affords considerable grazing in late fall and early spring, produces a profitable yield of seed the second year, and is one of the best available means of maintaining soil productivity.

A cropping system for upland mixed farming must be extremely flexible and must be governed by current weather conditions. Dry weather, wet weather, or destructive storms will modify cropping plans but will not necessarily defeat them. The farmer has the option of using substitute crops when weather conditions are adverse to the ones he has planned to grow.

Crops are at the mercy of the elements from planting time until harvest. Variations in temperature, sunshine, and rainfall cause large variations in yield from year to year. Weather hazards are reduced by timely tillage, moisture conservation, and prevention of weed growth and of abnormal soil erosion.

A simple 4-year rotation that produced reasonably good yields consistently for more than 30 years at the Lawton station consists of oats, kafir, cowpeas, and cotton, with barnyard manure applied to the kafir. This rotation provides some pasture, kafir grain and forage, a legume hay, and a cash crop. Such a rotation is susceptible of changes that may better fit it to the individual operator's farm needs. For example, wheat may be substituted for oats, a combine sorghum or sorgo for kafir, and some other legume and other cash crop for cowpeas and cotton. Application of barnyard manure to one-fourth of the cropped land each year as in this rotation is impracticable unless much feed is bought, but the results of limited fertilizer experiments indicate that much of the benefit obtainable from manure can be obtained through use of commercial fertilizers. These should supplement available manure rather than replace manure.

The crops in the rotation discussed are suitable also for sandy soils; but on such soils a rotation including sweetclover, hairy vetch, and early maturing corn is likely to give better results.

On creek and river bottom lands alfalfa becomes the backbone of the farming system. An operator who controls several hundred acres of land of this type generally has a large investment in livestock. On land not in alfalfa, his cropping is directed toward producing wheat and oats, for grazing in all years and for grain in the more productive years, and toward maintaining the productivity of grasslands.

A farming system, to be profitable and maintain productivity, must hold soil losses to the minimum, prevent unnecessary water loss through runoff, prevent weed growth, make use of the most suitable crop varieties and cropping practices, and use all practicable means of maintaining soil fertility. In most cases profitable farming involves using suitable quantities of needed commercial fertilizers to improve yields and help maintain soil fertility.

Reserves of livestock feed must be created in favorable years, for failures or low yields must be expected in about 1 year out of 4. Such reserves become especially valuable in a succession of low-production years.

A stable system of farming in southwestern Oklahoma requires a diversity of crops, livestock such as beef or dairy cattle or both, timely preparation of seedbeds, use of the best crop varieties, and space in which to store surplus feeds.

The weather at Lawton during the years 1916-49 was representative of that during the 75 years for which local weather records are available. Yields obtained during this period are indicative of those that might be obtained over a longer period.

SUMMARY AND CONCLUSION

The Lawton Field Station was established at Lawton, Okla., in 1915, for the purpose of determining possibilities and limitations of crop production in southwestern Oklahoma. Supplemental work consisted in variety tests of the principal cultivated crops, studies in crop adaptation, biological studies of insects, and crop-plant breeding for disease and insect resistance. The station's activities continued through 1949.

Annual precipitation on the station area within the 34-year period 1916-49 ranged from 17.23 to 43.92 inches. Monthly precipitation ranged from 0 to 14.12 inches. Rainfall distribution, rather than annual or monthly totals of rainfall, is a critical factor in crop production in southwestern Oklahoma.

Temperatures ranged from a maximum of 115° F. to a minimum of -9°. Maximum temperatures for the summer months were regularly high. The annual frost-free period averaged 214 days.

Injurious crop insects and plant diseases were a constant threat, necessitating quick and effective control measures.

The soil of the station area is Lawton silt loam. Its slow permeability and the torrential character of summer and fall rains made runoff and soil erosion a serious problem.

Losses of nitrogen from the 0-to-6-inch layer of the soil while the land was under cultivation ranged from about 45 percent under continuous cropping to small grain to about 60 percent under continuous row cropping. Applications of stable manure were not effective

in reducing losses of nitrogen, and plowing cowpeas under did not reduce the losses.

Tillage experiments with row crops and small grains indicated that timeliness of operations is very important. Early tillage that destroyed weeds and left the land receptive to rainfall was much more productive than tillage beginning shortly before seeding or planting.

Plowing to a depth of about 8 inches gave better results than shallow tillage. Little evidence was found that any crop other than corn was benefited by loosening the soil to a depth of 18 or 20 inches rather than 8 inches.

Listing for small grains was not so productive as plowing. Listing as a substitute for plowing produced higher yields of corn, but produced much lower yields of other row crops than plowing.

The expensive practice of plowing under crops of cowpeas or rye increased yields somewhat, but not enough to compensate the loss of a harvest.

Yields of both row crops and small grains were increased by summer fallowing, but not enough to justify the practice. Fallowing as a preparation for growing wheat is justified under certain special conditions.

Manure increased the grain yield or the vegetative growth, or both, of all crops and appeared to give cumulative benefit to rotations in which it was applied. It was particularly effective on corn grain and stover and on sorghum stover. The quantities needed for sustained crop production, however, are not produced in the course of general farming operations.

In preliminary commercial-fertilizer experiments, sorghums responded strongly to phosphorus but not to nitrogen. Weeping lovegrass responded to nitrogen with spectacular increases of seed, material increase of forage, and improved palatability of forage removed as hay. Application of nitrogen did not materially increase the yield of winter wheat or that of fall-sown oats, but application of phosphorus increased both to some extent. In a 1-year test, cotton showed no benefit from application of either phosphorus or nitrogen.

A relatively stable mixed-farming system for southwestern Oklahoma can be attained by making productive use of existing information. Farming systems best adapted to the area appear to be those in which production of livestock and of feed for livestock is the main enterprise. Cash crops are highly desirable. Rotations that produce pasture and feed for livestock plus a cash crop are well adapted to the tight soils of the upland. Sorghums, cowpeas, and corn are grown primarily for feed. Winter oats, winter barley, and sweetclover are combined pasture and feed or seed crops. Wheat and cotton are the principal cash crops.

A well-balanced farming system provides for applying the manure produced on the farm to the crop that responds most strongly to it. Additional benefits may be obtained by supplementing the manure with commercial fertilizers. Choice of fertilizer treatment must be governed by (1) the nature of soil deficiencies, (2) the crops to be grown, and (3) the probability that prospective resulting increases in yields can be maintained in the face of frequent critical moisture deficiencies. Most of the details of when and how to use fertilizers in southwestern Oklahoma remain to be worked out.

Field management is important. If both small grains and corn or sorghum are grown, the fields must be well separated to protect the corn or sorghum from chinch bugs.

Successful farming also requires selection of crop varieties best adapted to the section and storing of feed reserves from years of high production.

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APPENDIX

TABLE 16.—Monthly and annual precipitation at Lawton, Okla., 1916-49

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
1916	2.34	0.03	1.19	3.52	1.81	4.06	4.60	0.87	1.11	1.49	1.36	0.06	22.44
1917	.80	.57	1.74	1.28	1.50	1.01	3.02	2.84	.72	.19	1.08	.03	17.28
1918	.20	.25	2.16	2.36	1.29	3.08	2.57	1.48	4.18	8.08	1.20	3.50	30.95
1919	.54	1.41	2.99	4.60	5.44	4.36	4.36	1.98	1.67	13.78	2.25	.92	43.65
1920	1.04	.61	1.84	3.14	7.53	.69	1.88	4.18	2.05	8.78	2.29	.86	34.89
1921	1.15	1.47	2.05	2.14	1.30	5.93	2.95	.83	2.13	.03	(1)	.53	20.51
1922	.89	.46	.97	6.85	6.63	1.01	3.40	.64	1.61	2.46	1.04	.21	26.17
1923	1.37	.70	1.30	3.48	5.56	2.08	1.25	1.79	4.99	9.04	3.51	1.76	49.43
1924	.20	.11	2.47	3.88	3.36	3.36	1.39	4.15	.61	9.04	.50	.99	21.49
1925	.65	.82	(1)	5.78	2.00	.55	2.01	3.52	7.73	3.78	1.83	.11	28.98
1926	1.33	0	1.67	2.22	3.79	1.20	2.10	7.48	4.67	4.78	.22	1.30	33.96
1927	1.45	1.41	2.37	3.22	3.17	2.71	3.44	2.65	4.67	1.71	.72	1.33	28.85
1928	.59	1.26	1.08	3.22	2.78	8.01	2.28	1.21	.66	2.02	2.67	1.28	25.74
1929	.94	.80	3.10	.01	12.26	1.94	3.15	.31	4.43	2.30	1.25	.23	30.72
1930	.82	.19	.26	1.08	5.75	2.47	.57	.55	1.70	9.74	1.61	2.67	30.44
1931	.84	1.84	1.77	2.14	.93	1.20	1.75	1.70	.05	5.22	6.24	1.40	28.06
1932	4.26	1.87	.21	2.16	1.19	7.00	.74	4.98	1.23	1.10	.08	.42	29.26
1933	1.01	.96	3.30	2.46	6.27	.25	6.28	1.90	2.68	1.10	3.32	1.15	20.31
1934	1.17	2.18	1.46	.97	3.48	2.27	.54	.77	3.49	3.24	2.51	1.86	27.25
1935	.50	1.21	1.31	1.42	8.92	2.61	.54	1.31	1.82	.73	.13	1.50	22.15
1936	.64	(1)	.08	.29	5.06	3.63	.54	0	10.12	2.55	1.06	1.11	26.40
1937	.61	.03	1.75	2.72	3.57	2.14	1.46	3.08	6.20	2.70	2.06	.37	27.08
1938	.86	5.30	4.42	1.67	6.21	3.20	.96	.76	0	1.54	2.70	.59	17.23
1939	2.65	.31	2.29	1.83	1.83	2.93	5.24	2.87	0	1.98	4.53	1.23	28.91
1940	2.42	1.77	(1)	4.13	2.83	2.93	5.24	1.95	1.06	9.31	1.41	1.33	43.92
1941	.16	.90	1.15	4.00	6.53	6.78	2.29	1.17	5.99	3.58	.62	1.82	32.61
1942	.03	.57	1.97	3.51	.90	5.91	1.43	4.06	6.51	3.38	.40	2.73	28.25
1943	.51	2.02	1.18	2.01	14.12	3.02	.07	.88	1.43	1.02	2.82	1.89	28.94
1944	.45	2.41	3.71	3.46	2.01	3.25	3.25	1.30	2.83	3.68	.70	.09	38.09
1945	.91	1.59	1.52	3.46	1.30	6.58	.66	1.96	10.35	1.24	3.98	2.98	32.93
1946	.57	.04	.29	6.07	6.69	4.54	.65	3.73	3.17	.65	.37	1.89	26.42
1947	.07	.32	.19	6.07	7.44	1.51	.65	.70	2.23	3.28	.12	.09	21.58
1948	.37	3.72	2.22	3.33	3.33	3.15	3.40	2.46	.12	1.25	.37	1.19	30.66
1949	4.91	1.11	1.88	3.47	5.58	3.80	.16	1.57	3.04	3.95	0	1.19	28.70
34-year average	1.27	1.18	1.62	2.89	4.56	3.24	2.22	2.11	3.16	3.43	1.61	1.41	

(1) Trace.

TABLE 17.—*Monthly maximum and minimum temperatures at Lawton, Okla., 1916-49*

Year	January		February		March		April		May		June		July		August		September		October		November		December		Extremes	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	High	Low
1916	74	2	80	11	98	15	83	25	95	41	100	53	103	65	102	55	95	35	91	28	83	14	79	10	103	2
1917	78	3	93	5	90	22	90	31	95	38	103	46	107	61	101	51	100	44	97	34	80	30	75	5	107	3
1918	70	-5	91	6	91	23	90	31	101	42	108	63	103	60	106	63	101	41	92	34	75	25	75	10	108	-5
1919	63	10	74	18	79	22	83	32	83	48	92	47	100	65	104	63	99	53	87	38	75	21	72	7	104	7
1920	71	10	81	16	84	9	87	25	95	44	97	57	101	62	95	53	98	36	90	34	75	16	72	16	101	9
1921	74	17	79	10	84	27	90	32	94	44	94	62	100	65	105	62	100	44	91	31	84	25	80	10	105	10
1922	71	13	83	11	82	8	88	31	98	33	102	53	105	57	107	58	102	47	92	36	75	28	74	16	107	8
1923	75	21	70	15	80	12	91	31	98	33	103	53	107	65	107	60	93	51	83	37	70	27	76	11	107	11
1924	70	7	78	10	88	19	83	36	93	40	106	51	103	52	104	62	98	38	83	30	88	23	75	1	106	1
1925	68	10	80	21	88	20	85	36	92	45	104	59	103	55	101	59	101	53	89	21	73	25	70	10	109	10
1926	67	12	80	23	82	20	87	24	96	40	104	50	103	58	101	57	100	42	87	40	78	18	75	10	104	6
1927	73	15	77	19	80	22	85	32	98	41	98	57	101	58	102	60	97	44	87	40	84	26	64	6	102	6
1928	77	16	73	14	92	25	91	25	99	40	98	48	100	63	102	63	99	46	100	35	74	28	71	18	102	6
1929	63	-8	84	24	79	18	95	43	89	46	104	52	105	57	107	60	105	45	86	32	71	20	75	19	106	5
1930	70	17	73	29	77	19	80	30	92	40	100	57	105	54	103	55	104	54	97	32	80	29	68	22	107	-8
1931	70	17	83	24	88	25	87	34	91	45	96	54	104	63	104	60	95	51	93	30	77	15	75	7	104	7
1932	73	19	77	-2	83	25	89	31	96	42	105	51	105	59	100	60	97	59	88	37	82	26	77	16	105	-2
1933	77	2	81	14	88	21	92	35	93	48	103	62	108	64	108	60	94	49	87	38	85	26	68	18	108	14
1934	74	4	80	4	85	29	98	31	88	41	96	53	105	62	105	60	91	43	93	37	75	27	64	15	106	2
1935	77	2	81	14	85	23	91	31	93	40	108	55	115	60	114	60	101	44	89	29	80	21	66	22	115	4
1936	74	4	80	4	85	25	98	31	93	40	104	56	105	64	108	67	98	43	94	32	83	19	60	16	108	9
1937	61	9	80	15	85	25	85	27	94	38	96	62	102	65	103	64	101	44	100	33	79	17	78	17	103	12
1938	77	12	76	15	87	20	95	25	107	43	106	60	110	67	109	61	108	44	97	32	81	22	80	27	110	12
1939	74	22	74	12	87	20	91	28	96	40	97	52	102	58	106	55	100	42	93	33	75	14	70	22	106	-2
1940	63	-2	74	19	79	20	83	35	90	47	95	57	104	62	102	63	99	47	86	29	80	23	69	13	104	13
1941	72	23	73	11	84	25	88	36	94	35	101	52	101	61	102	65	93	37	85	32	81	25	71	20	102	1
1942	75	1	77	19	84	26	89	39	95	45	98	64	103	63	107	63	100	47	87	31	79	24	63	9	110	1
1943	80	-4	80	16	86	24	91	33	100	38	99	53	104	63	110	65	101	32	80	23	80	23	65	20	107	1
1944	70	4	75	16	75	21	83	33	94	37	98	52	102	62	107	62	102	40	83	35	87	19	70	11	102	11
1945	71	26	73	11	83	27	79	28	94	37	97	52	110	61	107	65	95	43	86	36	77	27	76	9	110	9
1946	70	13	76	13	81	13	86	34	95	40	100	44	108	60	108	68	109	47	96	42	75	23	72	19	109	9
1947	74	-9	72	14	84	13	86	34	95	40	103	57	102	61	107	58	105	45	91	26	78	18	81	16	107	1
1948	70	8	76	13	81	1	89	33	92	50	97	61	104	62	103	55	98	42	93	32	83	23	72	18	107	6
1949	71	6	68	14	79	23	89	33	92	50	97	61	104	62	103	55	98	42	93	32	83	23	72	18	107	6

TABLE 18.—*Dates of last killing frost¹ in spring and first killing frost in fall and length of frost-free period at Lawton, Okla., 1917-49*

Year	Last frost in spring	First frost in fall	Frost-free period	Year	Last frost in spring	First frost in fall	Frost-free period
			<i>Days</i>				<i>Days</i>
1917.....	Apr. 8	Oct. 18	193	1934.....	Mar. 30	Nov. 3	218
1918.....	Mar. 18	Nov. 18	245	1935.....	Apr. 12	Nov. 4	206
1919.....	Apr. 9	Nov. 9	214	1936.....	Apr. 6	Oct. 26	203
1920.....	Apr. 4	Nov. 1	211	1937.....	Apr. 8	Oct. 22	197
1921.....	Apr. 16	Nov. 9	207	1938.....	Apr. 8	Nov. 6	212
1922.....	Mar. 12	Nov. 13	246	1939.....	Apr. 18	Oct. 30	195
1923.....	Apr. 4	Nov. 5	215	1940.....	Apr. 12	Nov. 10	212
1924.....	Mar. 31	Oct. 23	205	1941.....	Mar. 28	Oct. 31	217
1925.....	Mar. 18	Oct. 27	223	1942.....	Mar. 31	Oct. 26	209
1926.....	Apr. 14	Nov. 4	204	1943.....	Mar. 21	Oct. 26	219
1927.....	Apr. 21	Nov. 11	204	1944.....	Mar. 30	Nov. 19	234
1928.....	Apr. 14	Nov. 2	202	1945.....	Apr. 5	Nov. 13	222
1929.....	Mar. 16	Oct. 23	221	1946.....	Mar. 8	Nov. 10	247
1930.....	Mar. 29	Oct. 28	213	1947.....	Mar. 27	Nov. 6	224
1931.....	Apr. 21	Oct. 30	192	1948.....	Mar. 28	Oct. 17	203
1932.....	Mar. 30	Oct. 10	194	1949.....	Mar. 18	Oct. 30	226
1933.....	Apr. 14	Nov. 7	207	Average 1917-49.....	Apr. 2	Nov. 2	214

¹ A temperature of 32° F. or lower was considered to be a killing frost, unless recorded plant data indicated otherwise.

TABLE 19.—*Monthly average wind velocity at Lawton, Okla., 1916-49*

Year	Velocity											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>	<i>M.p.h.</i>
1916.....	7.8	6.8	9.2	8.6	7.2	7.1	3.6	5.3	5.8	5.9	6.7	6.0
1917.....	5.8	3.8	10.0	10.8	7.8	7.0	6.2	5.2	4.6	7.7	5.3	6.7
1918.....	7.8	6.7	6.7	7.9	9.6	4.7	5.9	6.1	5.3	3.9	5.6	5.1
1919.....	4.4	7.4	6.9	6.7	4.9	3.3	4.0	4.6	5.5	5.9	5.2	5.8
1920.....	4.9	5.6	8.8	9.0	5.5	5.2	3.8	4.1	4.7	5.7	5.4	5.9
1921.....	6.4	6.0	7.9	8.1	6.1	4.5	4.3	4.4	5.8	6.1	5.7	6.5
1922.....	6.4	8.6	9.9	7.8	5.5	3.9	4.8	4.1	3.6	4.2	5.0	5.7
1923.....	5.4	6.4	9.7	7.6	6.9	5.2	3.3	4.6	4.0	4.4	4.0	6.6
1924.....	6.2	6.8	7.2	6.2	5.2	6.3	4.6	5.3	4.4	3.7	5.1	5.0
1925.....	5.7	6.8	8.0	7.5	5.1	5.9	5.5	3.3	3.8	5.0	4.4	5.8
1926.....	6.6	7.1	7.7	6.8	5.3	5.1	4.2	3.9	4.4	3.8	5.8	6.0
1927.....	6.3	7.7	8.1	6.7	7.1	4.8	3.7	4.2	5.4	4.5	6.9	6.4
1928.....	5.9	6.7	7.3	9.0	5.9	6.6	4.1	3.6	4.0	6.4	6.9	6.5
1929.....	8.2	7.5	8.6	8.0	7.4	6.1	4.1	3.9	3.4	4.0	5.2	4.7
1930.....	6.6	5.9	7.5	7.4	6.4	6.2	4.3	3.4	4.7	4.8	5.1	5.5
1931.....	5.8	6.8	10.2	7.1	7.2	6.4	5.0	4.6	5.7	4.9	5.5	5.2
1932.....	6.3	5.6	9.1	8.4	6.1	5.2	4.4	5.3	4.0	6.1	6.1	6.5
1933.....	4.1	5.4	7.9	7.4	6.0	5.5	4.6	3.9	4.9	4.6	5.2	5.2
1934.....	5.7	6.2	7.3	6.2	4.7	5.8	5.2	5.5	6.2	4.5	5.9	5.9
1935.....	6.5	6.9	8.1	8.3	6.6	4.9	3.2	4.2	3.6	5.9	5.4	4.7
1936.....	6.2	7.0	7.2	7.9	5.8	5.2	5.3	4.4	5.4	5.0	5.2	6.3
1937.....	7.8	7.9	8.8	7.7	5.8	4.8	5.4	3.6	4.5	4.5	6.2	6.2
1938.....	6.9	7.9	8.1	8.1	6.2	5.2	3.8	4.9	3.7	4.0	6.5	5.2
1939.....	6.1	8.0	7.0	8.1	6.5	7.0	5.6	3.9	5.3	5.6	4.3	4.9
1940.....	6.2	8.4	7.8	6.8	5.5	5.2	5.2	3.7	4.3	4.5	5.9	4.6
1941.....	5.3	5.5	7.1	6.4	4.5	3.3	3.0	3.7	4.7	4.2	3.8	4.8
1942.....	5.4	6.8	7.2	6.9	6.5	5.8	4.7	4.5	5.0	4.2	6.0	4.9
1943.....	5.7	5.8	8.2	6.0	6.8	5.3	3.8	5.2	4.5	4.9	4.4	5.0
1944.....	5.0	5.5	8.0	8.8	5.5	6.4	4.2	4.7	4.8	2.9	5.0	5.5
1945.....	4.8	6.5	5.7	5.9	6.9	6.4	3.5	3.3	5.4	3.6	4.4	4.6
1946.....	5.4	6.5	6.8	5.2	5.5	5.4	3.2	4.2	3.9	5.2	4.7	4.6
1947.....	4.4	5.6	7.1	6.9	4.5	5.4	3.6	3.7	4.0	4.1	4.5	4.7
1948.....	5.1	4.7	7.2	5.9	4.8	4.5	3.7	3.3	3.4	3.8	6.3	6.0
1949.....	5.8	4.8	7.2	5.1	4.6	3.6	3.7	3.5	3.3	3.6	3.2	4.6
Average.....	6.0	6.5	7.9	7.4	6.1	5.4	4.3	4.3	4.6	4.8	5.3	5.5

TABLE 20.—*Monthly and seasonal evaporation at Lawton, Okla., 1916-49*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Apr.-Sept.	Apr.-Nov.
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
1916			7.12	5.07	7.01	8.80	8.46	9.75	7.64	5.23			46.73	62.03
1917			6.46	8.40	7.31	10.24	10.06	12.13	8.51	7.41	3.60		51.02	58.74
1918				6.14	8.83	8.00	10.53	12.13	6.77	3.80	2.50		52.40	42.39
1919				4.76	5.41	5.36	7.18	7.98	6.10	3.07	2.30		37.02	44.41
1920				7.08	5.09	7.05	7.98	8.24	5.29	3.87	2.21	1.96	38.33	38.76
1921			3.68	5.21	6.41	5.14	7.05	8.10	6.85	3.75	2.53		39.57	46.54
1922		3.19	4.28	4.42	4.02	6.53	8.58	8.79	6.36	4.64	2.80	1.68	42.24	47.06
1923			2.97	6.49	6.10	9.07	8.06	9.95	5.36	3.02	1.80		43.53	51.66
1924			6.64	5.19	6.10	10.36	11.56	8.72	6.39	4.78	3.35		48.68	55.02
1925				4.67	6.35	9.01	8.74	7.62	6.15	3.82	2.52		42.64	50.02
1926			4.34	5.06	7.88	7.57	7.89	8.24	5.63	3.91	3.47	1.71	42.23	49.33
1927		2.67	4.51	5.11	6.15	6.32	7.60	7.97	7.52	6.14	2.53		40.67	49.31
1928		2.23	4.07	5.41	5.83	8.48	8.55	10.27	5.00	4.11	2.53	1.99	43.54	49.80
1929	1.98		5.09	6.25	5.51	7.75	10.47	10.10	8.05	3.39	2.56	1.43	48.13	51.08
1930	2.17		3.88	4.01	6.13	9.22	9.44	7.62	9.21	4.90	2.14		45.63	52.67
1931	1.71		4.81	5.93	7.18	6.98	9.20	8.48	5.30	5.93	3.77		43.13	52.83
1932				7.16	7.56	10.40	10.77	6.93	6.84	5.36	3.45		49.66	58.47
1933				5.07	7.18	11.28	14.43	12.89	7.00	5.47	3.28		57.85	66.60
1934				5.39	5.06	6.84	9.76	11.05	5.30	4.53	3.95		43.95	50.43
1935			6.77	7.66	7.03	9.38	12.39	13.19	6.65	3.94	3.10		56.50	63.54
1936			3.84	5.50	7.78	9.04	11.36	9.32	7.67	4.73	2.94		50.67	58.35
1937			5.19	3.83	6.85	8.08	10.28	12.24	8.27	6.93	3.76		49.56	60.25
1938			5.12	7.01	8.80	10.04	12.84	9.67	10.77	6.73			59.13	
1939			6.50	6.42	7.39	7.99	9.52	8.21	7.04	6.01	2.34		40.57	54.92
1940			3.79	4.24	5.42	6.00	7.97	7.59	5.73	3.38			36.95	
1941				3.60	7.35	7.39	8.93	7.19	5.72	3.71	2.96		40.18	46.85
1942				5.90	5.18	7.80	9.33	11.39	7.49	5.31	3.49		46.97	55.77
1943			3.58	6.09	5.84	8.67	8.30	9.21	7.02	3.80	2.39		45.13	51.32
1944			3.07	3.98	7.34	7.06	7.15	7.39	9.21	3.27	3.27		40.21	46.70
1945			4.38	5.72	6.62	6.94	9.79	9.15	5.79	4.31	2.62		44.01	50.94
1946			3.70	4.53	5.35	8.21	8.97	9.48	7.46	5.28	2.28		44.00	51.56
1947			2.90	6.49	5.88	7.81	8.85	9.48	7.97	4.87	3.66		44.46	52.99
1948			3.99	4.58	5.42	7.22	9.03	8.21	5.24	3.78			39.70	
1949														
Average 1916-49	1.95	2.70	4.61	5.53	6.48	8.05	9.38	9.09	6.76	4.68	2.85	1.75	45.29	52.82

TABLE 21.—*Mechanical analysis¹ of virgin Lawton silt loam soil*

Sample No.	Horizon	Depth	Organic matter	Distribution of particles by size class and diameter (in mm.)								Other classes		
				Fine gravel, 2-1	Coarse sand, 1-0.5	Medium sand, 0.5-0.25	Fine sand, 0.25-0.1	Very fine sand, 0.1-0.05	Silt, 0.05-0.002	Clay, ≤0.002				
											0.02-0.002	≤0.005	>2	
	471327	<i>Inches</i> 0-6	<i>Pct.</i> 2.6	<i>Pct.</i> 0.8	<i>Pct.</i> 3.2	<i>Pct.</i> 2.9	<i>Pct.</i> 11.0	<i>Pct.</i> 9.4	<i>Pct.</i> 55.7	<i>Pct.</i> 17.0	<i>Pct.</i> 17.4	<i>Pct.</i> 19.4	<i>Pct.</i> 1	
	471328	6-12	1.8	0.7	3.0	2.6	8.8	11.6	50.5	15.5	15.5	25.3	1	
	471329	12-15	1.6	0.7	3.7	2.6	7.3	8.9	47.8	29.0	16.9	31.8	1	
	471330	15-19	1.6	0.8	3.4	2.7	6.7	8.2	42.8	35.4	16.6	38.6	1	
	471331	19-30	1.5	2.0	4.6	2.7	7.2	7.5	33.0	43.0	12.9	45.6	2	
	471332	30-35	1.3	9.7	6.9	3.5	9.1	7.7	22.7	40.4	10.2	42.7	16	
	471333	35-45	0.8	1.4	3.2	3.2	11.6	10.3	26.7	43.6	9.4	45.2	2	
	471334	45-54	0.6	3.8	5.7	5.0	16.0	12.9	25.4	31.2	8.2	33.7	9	
	471335	54-61	0.2	6.8	9.9	5.6	13.0	11.2	27.9	25.6	9.0	28.4	14	

¹ Made in 1947 in the laboratories of the Plant Industry Station, Beltsville, Md.TABLE 22.—*Annual and average acre yields of winter wheat in tillage studies at Lawton, Okla., 1924-49*

Tillage method	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946 ¹	1947	1948	1949	Av- erage 1924- 49
Late plowed 4"	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Early plowed 4"	40.3	3.3	23.2	17.3	11.8	9.8	6.7	27.5	26.3	13.0	7.3	5.8	4.5	21.3	6.8	0	5.0	10.3	6.8	7.8	12.0	17.2	0	20.0	15.7	7.2	12.6
Early plowed 8"	38.8	2.8	26.0	17.3	15.7	8.8	6.7	27.5	26.2	15.3	8.8	8.8	9.2	25.2	7.5	2.5	9.3	12.3	3.5	10.7	21.8	19.3	0	22.0	17.3	13.2	14.5
Early plowed 8" and sub- soiled 10" to 12" additional	37.7	3.5	27.8	18.0	15.3	10.3	7.0	29.8	29.8	15.8	9.5	8.7	12.5	27.5	8.2	5.2	11.8	9.7	1.8	14.2	24.5	19.5	0	23.8	24.3	15.3	15.8
Alternately early plowed and early disked:	33.2	3.3	27.5	17.5	16.3	9.5	6.0	28.3	27.0	16.2	11.0	9.5	12.8	28.7	7.8	3.8	10.2	8.0	1.7	14.3	23.2	18.7	0	23.5	24.0	12.2	15.2
Plowed	39.5	4.3	31.3	18.3	17.2	8.0	6.5	28.2	27.3	16.2	10.0	8.8	10.8	24.5	5.8	4.5	11.3	9.2	1.0	12.8	21.2	17.3	0	20.8	20.2	14.0	15.0
Disks	40.2	2.5	26.3	15.8	15.5	8.3	5.7	29.2	23.2	14.5	9.3	9.2	9.0	25.0	6.7	2.8	9.5	10.3	1.2	13.3	22.0	13.8	0	14.8	17.5	12.2	14.0
Early disked	34.3	5.7	22.8	15.3	14.0	4.8	5.0	18.8	13.2	14.2	7.7	8.2	7.0	21.7	4.3	2.0	10.2	11.8	2.2	11.2	19.0	11.3	0	13.8	13.0	8.5	11.6
Late disked	34.2	3.8	19.5	11.5	10.2	5.2	3.8	15.8	13.3	9.0	4.5	5.3	3.0	15.3	3.7	0	6.2	8.0	2.2	4.3	8.5	9.3	0	4.2	4.3	3.7	8.0
Early listed ²	43.0	5.5	25.0	17.7	15.5	8.3	4.3	25.5	22.8	19.5	8.0	9.3	7.3	27.3	5.5	2.0	8.8	9.8	3.8	13.5	21.8	13.8	0	15.7	11.2	9.3	13.6
Early listed, manured ²	46.0	4.0	27.7	10.3	8.7	6.2	2.5	27.2	24.0	19.0	3.7	10.3	0	25.8	9.3	0	2.2	10.8	7.5	10.5	26.0	15.0	0	22.2	15.0	13.3	13.4

¹ Complete crop failure due to greenbugs.² Regular listing in 1924-37, basin listing in 1938-49.

TABLE 23.—Annual and average acre yields of winter wheat in 2- and 3-year rotations, Lawton, Okla., 1924-49

Previous crop, and cropping method	Rotation No.	Year																				Average 1924-49						
		1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943		1944	1945	1946	1947	1948	1949
Cotton:		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	
	Drilled in stalks.....	195 33.2	3.0	21.3	11.3	17.0	9.3	0.8	29.8	28.3	11.2	7.5	9.8	9.3	28.2	8.5	3.0	8.0	7.5	1.7	13.7	17.8	11.7	17.3	16.5	16.2	8.8	13.5
		197 31.2	4.5	23.3	10.0	15.5	7.8	3.3	25.5	25.7	10.7	7.7	8.5	8.7	24.2	6.5	2.7	7.8	7.8	2.5	9.3	18.7	10.5	9.2	14.3	15.2	7.2	12.5
		260 34.8	3.3	22.0	9.3	15.8	9.0	2.7	25.0	30.0	8.2	9.8	8.2	11.2	26.3	11.3	0	10.2	4.8	4.2	12.8	24.8	12.5	18.8	16.3	20.3	5.3	13.7
		332 33.8	4.2	20.2	10.5	13.2	10.3	1.2	30.3	28.0	10.8	8.3	11.7	10.7	27.2	5.5	1.3	7.8	6.7	1.8	12.5	19.7	12.5	16.0	17.5	16.3	9.2	13.3
	Drilled in stalks, green manure in rotation.....	202 33.2	3.3	22.3	11.7	18.5	10.5	1.7	35.0	27.7	11.7	8.3	10.0	9.7	30.3	8.0	4.0	9.7	7.3	4.1	12.5	18.3	11.5	13.0	17.5	18.8	9.2	14.1
	Drilled in stalks, topdressed.....	204 33.2	6.5	20.7	9.3	11.7	9.8	3.3	31.3	29.8	16.2	10.7	11.2	12.2	27.8	8.0	3.0	8.3	10.2	4.7	13.0	24.5	18.2	17.2	20.2	19.8	12.5	15.1
	Topdressed, drilled in stubble.....	193 31.0	3.5	23.5	9.3	13.7	9.5	3.8	31.8	27.2	14.7	7.0	12.2	8.5	30.0	8.7	2.3	8.3	13.0	1.5	13.2	23.2	18.7	20.2	22.7	22.3	10.3	15.1
	Wheat:																											
	Early plowed.....	197 34.5	4.5	20.3	13.0	14.5	10.7	6.3	27.0	27.2	17.2	9.8	9.8	5.3	28.8	7.7	3.8	9.8	11.7	8.1	11.0	17.8	14.0	0	17.8	16.2	10.5	13.8
Early plowed, manure in rotation.....	204 35.2	3.7	23.0	13.2	14.8	10.7	5.3	31.0	31.2	21.5	10.8	13.2	0	30.2	10.2	4.3	10.7	9.0	4.0	15.3	25.7	20.5	0	29.0	22.5	16.3	16.1	
Oats: early plowed.....	231 42.0	2.0	27.7	14.7	21.0	9.8	6.7	19.3	33.0	19.2	16.8	7.8	12.7	30.7	11.8	3.8	11.3	11.0	2.7	16.8	24.7	18.8	18.7	21.7	22.8	8.7	16.9	
Barley: early plowed.....	222 37.0	2.5	27.5	13.7	17.7	8.7	7.2	23.7	35.5	20.0	16.5	8.7	12.5	23.2	10.2	3.0	11.0	12.0	2.3	17.0	20.3	17.7	17.8	20.8	23.7	8.7	16.2	
Cowpeas:	204 38.3	3.5	22.2	14.5	18.3	9.5	7.8	24.5	31.3	20.2	13.8	8.7	14.7	28.3	9.2	4.5	12.7	7.8	2.3	17.8	22.5	17.0	0	20.7	23.0	10.0	15.6	
Disked.....	209 40.3	8.8	25.5	8.8	18.2	9.7	7.3	31.7	29.0	19.8	11.2	13.3	3.3	32.8	8.7	0	9.8	14.3	2.2	12.7	20.5	16.0	15.7	26.5	18.2	12.3	16.0	
Disked, topdressed.....	213 40.6	9.8	27.5	10.0	20.5	11.7	7.5	32.5	29.8	24.0	12.2	11.5	7.2	31.8	9.8	5.7	11.0	11.0	2.3	14.7	17.2	14.0	8.2	19.2	16.5	8.8	16.1	
On green manure.....	334 40.5	9.5	25.7	13.2	18.2	15.7	5.8	32.5	35.0	27.5	13.0	11.2	6.2	32.7	11.8	5.2	14.7	12.0	4.7	19.7	28.8	20.7	0	25.8	27.8	8.7	18.0	
Fallow:	199 44.3	9.3	31.5	10.5	24.2	13.5	9.0	32.5	33.2	25.3	11.3	10.7	4.7	33.2	11.0	10.3	11.5	17.0	4.0	19.2	26.8	16.8	12.5	32.7	22.5	9.3	18.8	
Unmanured.....	233 41.2	8.8	24.8	13.3	22.8	14.2	7.3	29.2	32.8	20.7	17.3	10.3	8.3	28.5	11.7	5.2	17.3	6.7	3.2	15.5	30.0	15.5	0	20.8	34.3	7.5	17.3	
Unmanured, wheat topdressed.....	257 42.0	12.0	27.0	15.2	25.5	15.7	9.5	31.7	36.0	21.8	21.5	15.3	21.5	51.3	10.5	8.5	21.3	9.0	3.5	15.2	30.5	17.5	0	18.5	36.2	7.2	19.4	
Manured, wheat topdressed.....	239 45.0	15.0	25.8	15.2	26.3	24.2	6.2	35.5	36.5	29.8	21.5	19.0	18.7	35.5	12.0	11.0	19.0	10.8	6.7	21.8	38.0	20.2	0	24.0	38.5	16.2	22.0	
Manured.....	238 46.0	13.2	28.0	13.5	27.5	22.3	6.3	35.0	37.5	30.0	19.5	19.7	17.0	34.2	6.8	10.3	23.7	6.7	6.5	20.2	35.2	19.8	0	22.7	38.5	13.8	21.3	

TABLE 24.—Annual and average acre yields of seed cotton in tillage experiments, Lawton, Okla., 1917-49

Treatment	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
Continuous methods:	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Spring plowed, surface planted	600	0	1,020	1,230	410	260	780	460	860	860	1,180	460	470	110	860	710	850	120
Winter plowed, surface planted	610	0	1,100	1,330	410	330	770	460	830	1,400	1,400	520	560	160	1,020	780	940	160
Winter plowed and subsoiled, surface planted	670	0	980	1,265	360	420	330	850	650	800	1,330	570	580	220	1,040	940	860	200
																	1,020	170
Winter listed, lister planted	460	0	800	820	280	270	300	600	450	840	980	380	360	130	600		840	110
																	1,030	120
Spring listed, lister planted	440	0	630	820	200	240	200	530	330	810	850	350	350	120	510		680	80
																	950	90
Winter plowed, lister planted	560	0	890	1,400	470	400	330	720	500	880	1,280	590	490	140	790		1,230	160
																	1,280	140
Alternately fallowed and cropped, surface planted	690	0	1,020	1,000	340	430	360	700	700	950	1,300	630	680	180	1,130	850	970	160
Average																		
Continuous methods:	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Spring plowed, surface planted	230	60	270	440	260	810	610	1,120	290	560	560	780	370	400	750	520	601	496
Winter plowed, surface planted	310	90	270	450	330	780	710	1,060	310	540	810	390	400	820	540	655	524	524
Winter plowed and subsoiled, surface planted	290	130	260	540	420	880	660	1,200	330	740	1,000	470	470	410	1,020	630	671	591
	310	80	250	530	300	740	840	1,390	330	550	910	470	400	870	590	590	569	569
	340	80	290	660	330	780	800	1,540	440	530	1,010	570	570	540	880	690	628	628
Winter listed, lister planted	200	30	260	410	340	680	620	840	130	480	480	170	330	280	510	250	485	381
	200	40	270	420	330	700	600	940	120	510	510	310	320	320	510	260	425	412
Spring listed, lister planted	150	20	210	390	300	710	610	730	120	410	410	270	310	340	590	300	366	366
	190	30	250	400	300	680	580	790	120	470	470	300	310	300	490	290	629	385
Winter plowed, lister planted	290	80	300	550	350	770	950	1,570	360	560	560	990	530	450	820	580	629	622
	240	80	350	630	330	670	720	1,570	350	570	1,060	460	430	430	820	640	604	604
Alternately fallowed and cropped, surface planted	500	140	370	500	770	940	860	1,250	330	630	630	810	430	400	870	440	678	614

TABLE 25.—*Annual and average yields of seed cotton in rotations at Lawton, Okla., 1924-49*

Previous crop, and cropping treatment	Ro- ta- tion	Annual acre yields																				Av- er- age yield						
		1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943		1944	1945	1946	1947	1948	1949
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
Cow-peas:																												
Disked		166	910	650	570	1,560	670	610	240	760	860	1,130	100	210	40	189	370	410	713	760	1,290	300	460	810	510	430	740	520
Fall plowed		167	950	590	600	1,540	530	640	210	850	820	1,070	100	193	30	225	380	420	756	510	1,210	310	450	630	560	470	790	430
Cotton: Fall plowed		276	1,050	840	720	1,630	770	760	210	1,340	870	1,350	110	330	80	210	610	550	1,020	870	1,520	440	730	1,080	520	470	1,200	550
Cotton: Fall plowed		275	1,440	590	690	1,610	580	730	190	970	1,070	1,200	160	310	40	210	240	340	630	960	1,250	460	360	1,020	480	330	930	760
Corn:																												
Spring plowed		142	1,080	590	550	1,430	590	610	180	760	900	950	110	210	40	188	400	440	833	910	1,670	410	680	770	450	450	740	641
Fall plowed		274	1,170	590	640	1,620	610	750	240	980	870	1,290	120	390	40	200	520	370	756	900	1,250	450	500	830	480	500	860	630
Sweetclover: Fall plowed		133	1,200	450	330	1,430	450	440	770	1,300	1,080	1,160	910	80	240	60	190	440	370	730	800	1,300	320	550	1,040	520	400	610
Fall plowed		134	1,200	430	320	1,400	530	630	240	1,080	940	1,100	70	300	30	190	510	540	650	880	1,830	360	530	830	760	460	840	740
Fetaria: Fall plowed		205	1,180	510	1,120	1,620	500	630	180	1,190	830	1,190	180	270	60	238	300	440	1,163	610	1,180	350	530	970	440	440	860	589
Drilled sorgo: Fall plowed		275	1,390	490	800	1,640	590	820	130	990	1,140	1,500	110	290	40	220	450	290	633	1,070	1,230	390	430	780	480	480	830	750
Wheat:																												
Fall plowed		195	710	410	540	1,170	480	620	140	940	590	720	140	220	20	133	290	270	640	830	1,380	290	540	1,000	410	270	960	560
Fall plowed		197	650	420	540	1,240	470	520	140	850	620	560	140	150	0	140	310	250	763	750	1,240	340	490	740	480	360	730	630
Fall plowed		203	610	460	600	1,230	520	530	150	890	740	540	120	320	30	150	400	370	710	850	1,240	370	520	870	460	370	900	620
Fall plowed		204	190	240	540	1,250	530	530	140	560	500	630	130	270	40	170	260	320	740	700	1,260	380	680	1,080	440	520	1,100	760
Fall plowed (cot- ton tressed).		392	870	600	800	1,100	550	550	240	800	730	640	150	310	30	170	400	370	550	880	810	350	570	1,040	570	600	1,020	600
Fall plowed (cot- ton tressed).		198	600	450	550	1,270	540	560	110	860	640	570	130	340	30	150	350	240	780	820	1,400	410	650	1,150	550	470	930	780
Fall pl., wet, green manure in rota- tion																												
Spring plowed		199	490	430	490	1,200	580	570	150	890	640	550	130	290	30	170	410	530	730	950	1,370	370	580	980	480	460	1,060	740
Spring plowed		200	530	480	630	1,240	460	550	120	800	750	830	110	380	30	170	450	433	780	910	1,300	390	570	830	430	476	870	660
Spring plowed		200	850	350	440	1,180	460	600	110	590	740	960	90	410	30	130	440	300	589	860	1,120	390	530	1,070	450	470	850	720
Cotton:																												
Fall plowed		195	730	590	550	1,180	490	510	130	910	610	510	110	210	30	90	350	240	563	780	1,130	310	420	970	430	310	860	620
Fall plowed, ma- nure in rotation.		198	530	490	670	1,330	480	570	120	910	730	620	130	380	40	150	400	220	710	880	1,170	330	550	950	420	540	850	660
Barley: Fall plowed		196	650	420	530	1,150	500	450	130	880	480	930	90	130	30	100	240	270	675	760	1,140	240	520	840	420	320	820	600
Barley: Fall plowed		201	610	540	510	1,160	530	440	130	890	470	570	140	100	30	110	240	240	745	660	1,100	250	450	550	440	220	810	570

Cowpeas:	394	820	740	1,210	690	600	180	970	620	100	300	30	250	380	540	730	1,120	610	470	640	920	570	690	960	780	639
Spring plowed (cotton top-dressed).....	394	810	730	1,130	630	550	190	900	610	580	110	300	40	240	380	530	700	1,070	1,030	470	610	790	450	590	900	760
Spring plowed.....	395	950	810	1,240	590	690	160	920	650	820	90	250	50	167	620	510	770	1,430	250	590	1,020	370	300	950	590	615
Green manure.....	396	670	760	1,370	760	690	230	1,140	700	750	140	350	60	280	470	850	670	1,160	1,220	520	750	1,080	520	780	990	732
Rye, plowed under.....	390	690	1,060	1,330	700	810	240	880	900	1,350	160	400	50	200	510	600	600	1,220	520	500	770	1,080	570	840	1,070	720
Oats, Fall plowed.....	391	830	670	680	1,180	490	590	210	890	730	130	330	30	200	440	400	520	960	1,240	390	630	1,010	510	600	1,020	670
Peanuts or Mung beans: Spring plowed ¹	393	980	670	860	1,170	670	590	130	890	590	130	250	40	200	380	390	600	1,010	860	420	520	800	430	600	950	720
Fallow.....	397	910	660	830	1,230	630	680	200	1,050	630	880	140	70	330	500	830	680	1,100	600	490	810	860	410	770	1,030	980
Fallow, manured.....	398	1,000	690	820	1,450	720	810	290	1,170	800	1,340	180	100	300	540	940	680	1,230	670	540	770	1,010	530	840	1,150	799
Fallow (cotton top-dressed).....	399	920	690	540	1,360	650	620	240	960	770	1,130	160	120	290	490	840	640	1,090	970	400	880	920	550	640	1,010	1,020
706																										

¹ Peanuts in 1924-42, Mung beans in 1943-49.

TABLE 26.—Annual and average acre grain yields and average stover yields of kafir and fetcrita in tillage experiments, Lawton, Okla., 1924-49

Crop and cropping method	Plot	Annual acre yields of grain																								Average age of stover ¹	Average age of stover ¹	Average age of stover ¹	
		1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947				1948
		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	
Kafir:	Spring plowed.....	MCA	30.0	7.3	25.3	23.3	35.5	21.8	0	29.3	29.7	0	0	0	14.3	25.8	0	34.3	33.0	23.2	0	0	0	0	0	23.2	14.7	14.3	2,900
	Manured and spring plowed.....	MCH	30.7	15.2	22.2	28.7	33.0	25.7	0	28.0	39.8	0	0	0	11.2	23.7	0	30.0	31.2	23.0	0	0	0	0	0	23.5	10.2	14.5	4,176
	Fall plowed.....	MCI	33.0	12.5	25.7	29.0	36.2	30.3	0	32.8	34.5	0	0	0	16.2	29.3	0	31.7	38.8	21.2	0	0	0	0	0	28.7	18.0	16.2	3,109
	Fall plowed and subsoiled.....	MCE	33.7	13.0	25.5	27.8	38.8	25.8	0	41.2	35.3	0	0	0	15.3	32.5	0	32.7	35.7	18.8	0	0	0	0	0	31.7	23.7	16.6	3,425
	Lister planted.....	MCF	21.0	14.7	21.2	23.7	22.0	24.8	0	25.2	28.7	0	0	0	14.5	24.7	0	24.0	20.7	0	0	0	0	0	0	16.8	16.2	11.4	2,830
	Cultivated and lister planted.....	MCG	28.8	15.3	22.3	24.8	19.8	24.8	0	21.0	29.2	0	0	0	15.2	23.7	0	25.0	24.2	0	0	0	0	0	0	11.0	12.8	11.5	3,094
	On fallowed land.....	MCC-D	34.8	19.8	30.5	28.8	50.5	52.2	8	33.3	38.0	0	0	0	27.4	35.3	0	40.2	40.3	32.0	0	0	0	0	0	30.8	25.2	19.2	4,019
Feterita:	Spring plowed.....	MCA	25.3	2.9	18.1	21.4	22.9	17.9	2	8.31	9.15	9	0	7	9	15.3	9	0	28.1	12.4	13.3	0	0	13.8	0	11.6	27.1	17.1	2,294
	Fall plowed.....	MCH	26.9	5.3	20.5	25.0	19.7	29.0	4	0.33	1.20	0	0	17	1	0	17.1	0	23.4	17.1	11.7	0	0	15.5	0	13.1	0.20	3.8	2,531
	On fallowed land.....	MCC-D	25.0	11.0	16.0	21.2	32.4	25.0	5	9.92	8.21	0	0	17	4	0	17.4	0	41.0	22.8	19.1	0	0	19.1	0	9.7	34.0	21.1	15.9

¹ In 1924-48.

TABLE 27.—*Annual and average stover yields of kafir grown continuously on the same land by different methods of listing, Lanton, Okla., 1924-47*

Cropping method	Annual acre yields of grain																Average age of grain	Average age of acre yield of stover							
	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	
Fall disked, winter listed, leveled in spring, lister planted in same furrows	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Fall listed, leveled in winter, lister planted in same furrows	24.7	14.8	23.3	17.5	27.3	15.8	0	23.0	23.8	0	0	0	0	15.7	18.8	0	28.7	21.2	14.8	0	0	0	0	0	0
Fall listed, leveled in spring, lister planted in same furrows	22.2	12.7	23.3	17.3	24.7	17.5	0	21.3	22.7	0	0	0	0	12.2	15.3	0	25.0	26.7	12.7	0	0	0	0	0	0
Fall listed, leveled in spring, lister planted in same furrows	20.7	14.7	21.3	12.7	25.7	15.0	0	20.7	17.3	0	0	0	0	10.8	14.3	0	24.3	16.0	10.2	0	0	0	0	0	0
Fall listed, harrowed in spring, lister planted by splitting ridges	22.2	9.3	22.2	9.5	20.7	12.0	0	18.7	17.7	0	0	0	0	6.5	8.2	0	18.7	18.3	0	0	0	0	0	0	0
Spring listed, cultivated, lister planted in same furrows	25.2	14.2	24.3	19.2	24.0	12.3	0	21.7	21.0	0	0	0	0	13.3	18.0	0	28.0	18.0	11.8	0	0	0	0	0	0
Spring listed, lister planted by splitting ridges	23.2	13.0	21.3	16.5	26.8	12.0	0	21.0	24.5	0	0	0	0	13.5	16.8	0	25.8	7.7	10.5	0	0	0	0	0	0
Fall disked, manured, winter listed, leveled in spring, lister planted in same furrows	24.7	11.8	22.5	14.3	28.7	20.3	0	23.0	24.0	0	0	0	0	10.8	18.2	0	26.0	7.5	10.3	0	0	0	0	0	0
	31.0	15.0	25.8	21.3	29.3	29.2	0	23.8	33.3	0	0	0	0	27.8	28.2	0	29.0	8.8	26.7	0	0	0	0	0	0

TABLE 28.—*Annual and average total yields of sorgo seed in tillage and rotation experiments, Lawton, Okla., 1924-49*

Previous crop and cropping method	Plot or rotation	Annual total acre yields													1937
		1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Sorgo:															
Spring plowed	MCA	8,200	1,700	6,650	3,600	8,000	5,050	1,500	7,800	6,880	3,050	1,650	4,270	1,380	3,600
Spring plowed, topdressed	MCH	11,300	4,900	7,750	9,950	11,000	9,800	4,300	12,000	8,720	9,750	3,350	5,350	4,170	6,600
Fall plowed	MCH	7,900	1,900	6,650	6,360	7,250	3,200	1,430	7,300	8,440	3,200	2,250	4,600	1,420	4,300
Fall plowed and subsoiled	MCE	8,300	2,700	6,950	4,130	7,500	9,000	2,250	7,800	10,160	4,600	2,650	4,820	3,220	4,600
Lister planted	MCE	6,150	3,150	7,300	4,350	10,550	6,700	2,450	8,130	8,460	1,950	2,650	3,510	1,720	4,250
Spring tilled, lister planted	MCG	6,150	3,150	7,400	3,550	9,150	8,550	2,750	9,020	10,380	3,150	3,300	4,570	1,220	5,100
Fallow	MCC-D	8,900	4,400	7,700	7,170	10,950	9,800	2,900	8,500	10,420	3,900	2,550	3,800	3,510	5,350
Kafr: Fall plowed	P 274	7,900	2,760	13,250	8,800	9,750	13,400	1,100	11,200	13,800	3,900	1,700	4,150	1,500	8,850
	U 275	9,900	2,800	16,300	12,800	9,500	9,200	2,230	9,650	16,100	4,100	3,050	5,200	2,300	10,300
		Average													acre yield of seed
		Annual total acre yields													
Previous crop and cropping method	Plot or rotation	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949		
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Sorgo:															
Spring plowed	MCA	4,720	650	7,750	7,500	6,940	4,840	3,280	7,760	3,120	3,300	5,000	4,700	4,710	518
Spring plowed, topdressed	MCH	8,230	2,500	9,710	11,970	14,600	7,750	9,420	15,520	9,500	4,500	13,580	7,500	8,666	1,169
Fall plowed	MCH	4,650	1,100	8,110	7,200	9,080	5,120	3,230	8,600	3,800	3,150	4,500	5,200	4,927	1,584
Fall plowed and subsoiled	MCE	5,850	1,500	8,840	9,580	7,620	4,950	5,420	9,320	5,710	4,150	7,250	6,700	5,978	805
Lister planted	MCE	5,350	2,100	8,790	6,530	1,750	3,140	6,050	7,450	1,610	3,800	5,470	3,350	4,962	554
Spring tilled, lister planted	MCG	6,340	2,250	8,990	7,970	2,500	1,210	5,640	9,180	5,500	3,900	6,700	4,200	5,570	578
Fallow	MCC-D	5,920	3,050	11,060	9,180	7,040	7,020	5,600	10,880	6,240	3,000	6,400	6,600	6,777	783
Kafr: Fall plowed	P 274	10,530	3,700	26,050	26,050	13,550	3,850	6,130	10,300	13,250	3,950	11,650	7,300	8,604	(2)
	U 275	11,900	4,650	9,800	32,890	14,450	10,250	8,250	11,400	11,200	3,500	13,400	7,800	9,726	(2)

1 Seeded with grain drill

2 Out for hay, no seed harvested.

TABLE 29.—Annual and average grain yields and average stover yields of kafir and feterita in rotation experiments, Lawton, Okla., 1924-49

Crop, previous crop, and cropping method	Rotation No.	Annual acre yields of grain																Average acre yield of grain stover										
		1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939		1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Kafir:																												
Kafir, spring plowed	160	26.5	11.7	19.3	19.3	33.3	219.0	0	23.3	25.0	0	0	0	0	10.3	14.7	0	23.0	31.5	19.8	0	0	22.5	0	0	18.3	2.8	Bu.
Kafir, fall plowed	255	36.2	9.8	27.8	31.3	32.8	25.3	0	31.7	35.3	0	0	0	0	15.2	29.2	0	24.2	46.0	18.3	0	0	0	0	0	24.2	12.1	Bu.
Kafir, fall plowed, manured	256	28.7	7.7	16.8	33.3	31.0	23.0	0	27.7	36.8	0	0	0	0	21.0	30.7	0	25.3	20.3	19.0	0	0	0	0	0	27.8	18.7	Bu.
Feterita, fall plowed	161	29.7	11.7	21.8	18.2	42.7	22.7	0	36.3	37.7	0	0	0	0	20.2	29.8	0	33.0	35.3	17.5	0	0	31.5	0	0	25.0	6.3	Bu.
Feterita, spring plowed	165	32.2	12.7	27.0	14.0	32.0	18.3	0	34.7	23.0	0	0	0	0	16.2	23.2	0	29.8	34.0	14.7	0	0	17.7	0	0	23.2	6.0	Bu.
Feterita, spring plowed	162	25.7	10.7	21.8	14.2	25.8	19.5	0	31.3	23.0	0	0	0	0	16.3	18.3	0	33.0	30.5	20.8	0	0	19.8	0	0	17.2	10.3	Bu.
Cotton, spring plowed	167	28.2	8.2	18.8	9.2	24.8	23.8	0	24.8	31.3	0	0	0	0	13.8	29.7	0	23.8	37.5	26.3	0	0	25.5	0	0	18.8	12.5	Bu.
Cotton, listed	274	28.8	0	20.7	15.0	23.5	16.8	0	30.2	25.0	0	0	0	0	13.2	25.7	0	26.8	34.8	24.2	0	0	15.5	0	0	22.0	9.2	Bu.
Cowpeas, spring plowed	134	30.5	5.7	12.2	25.0	23.3	18.8	0	27.3	30.2	0	0	0	0	14.7	30.7	0	31.8	38.3	24.3	0	0	0	0	0	19.7	9.3	Bu.
Cowpeas, fall plowed	160	27.7	15.8	14.3	9.5	30.2	23.0	0	27.3	31.7	0	0	0	0	10.2	21.3	0	23.2	31.0	27.2	0	0	23.5	0	0	26.8	9.7	Bu.
Oats, fall plowed, manured	163	31.0	11.5	13.3	17.5	33.3	31.3	0	33.3	33.2	0	0	0	0	16.5	25.7	0	30.5	36.8	27.3	0	0	34.8	0	0	25.2	7.8	Bu.
Fallow	276	37.3	10.8	14.2	37.5	53.4	32.7	0	33.5	39.0	0	0	0	0	21.0	36.0	0	27.5	27.3	23.2	0	0	0	0	0	31.0	16.3	Bu.
Feterita:																												
Kafir, spring plowed	169	20.7	4.3	12.8	14.8	26.9	21.0	0	3.3	30.3	15.5	0	0	0	9.0	12.9	0	22.4	13.6	13.6	4.3	0	9.3	0	0	12.2	19.7	Bu.
Kafir, fall plowed	163	22.1	5.3	17.6	7.9	21.4	27.9	0	5.5	37.9	22.1	0	0	0	9.5	23.6	0	24.1	19.8	11.7	5.5	0	23.1	0	0	8.1	26.2	Bu.
Cotton, spring plowed	168	26.9	4.0	14.3	11.2	4.7	4.4	0	5.2	37.2	12.8	0	0	0	14.7	20.3	0	23.6	17.1	12.2	6.0	0	11.4	0	0	11.7	28.4	Bu.
Cowpeas, spring plowed	162	23.3	5.9	9.1	6.6	17.9	28.6	0	23.5	15.5	0	0	0	0	6.0	14.0	0	18.4	25.9	4.0	2.1	0	18.1	0	0	12.2	24.8	Bu.
Cowpeas, fall plowed	162	22.8	8.3	12.9	0	21.0	24.7	0	3.1	31.7	16.9	0	0	0	7.2	16.7	0	24.0	21.2	16.0	4.3	0	10.7	0	0	11.2	27.2	Bu.
Cowpeas, plowed under	205	29.8	6.2	19.1	21.7	33.4	41.4	0	6.0	42.8	31.7	0	0	0	14.8	0	0	25.9	28.8	11.4	6.7	0	24.1	0	0	12.6	34.0	Bu.
Fallow	165	24.5	10.5	17.9	4.3	27.1	27.2	0	5.5	32.4	7.8	0	0	0	17.6	0	0	25.2	19.7	14.1	5.7	0	19.8	0	0	14.5	25.9	Bu.

TABLE 30.—Annual and average yields of corn grain and average yields of corn stover in tillage and rotation experiments at Lawton, Okla., 1917-49¹

Preceding crop, and cropping method	Plot or rotation	Acre yields of corn grain													Average acre yields			
		1919	1920	1921	1922	1923	1924	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	
Corn:	Spring plowed	Bu. 42.7	Bu. 21.5	Bu. 32.2	Bu. 11.3	Bu. 11.1	Bu. 14.7	Bu. 7.1	Bu. 22.0	Bu. 16.8	Bu. 25.1	Bu. 2.3	Bu. 6.1	Bu. 27.3	Bu. 0	Bu. 2.5	Bu. 21.9	
	Spring plowed, corn topdressed	MCA 43.3	21.6	45.0	22.9	10.5	20.3	10.9	28.3	26.0	38.0	14.8	16.9	35.3	18.3	9.2	26.1	
	Fall plowed	MCB 40.1	24.1	28.8	12.9	13.7	14.5	6.3	23.6	18.3	25.9	2.5	6.9	26.1	0	2.5	22.1	
	Fall plowed and subsoiled	MCE 49.2	29.5	40.7	17.9	15.1	19.5	12.1	26.5	25.1	27.2	8.3	15.7	34.8	13.6	11.1	27.3	
	Lister planted	MCF 39.3	26.0	31.3	10.3	7.1	14.7	10.1	14.5	17.1	23.3	10.3	15.7	26.8	8.7	3.3	24.3	
	Early cultivated, lister planted	MCG 30.9	25.6	33.6	12.9	7.5	19.2	12.5	12.0	23.3	29.9	11.6	17.2	30.9	13.1	6.3	27.9	
	Oats, spring plowed	142 32.9	18.3	29.3	12.3	5.2	16.0	0	26.1	16.4	26.8	2.1	12.0	17.5	0	2.4	21.1	
	Sorgo, fall plowed	274 49.5	24.9	46.7	16.9	16.9	19.1	16.5	24.8	24.7	29.6	8.7	16.1	27.6	8.7	2.1	18.6	
	Fallow	MCC-D														2.0	25.7	
Preceding crop, and cropping method	Plot or rotation	Acre yields of corn grain													Average acre yields			
		1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	197-49	1924-49	
Corn:	Spring plowed	Bu. 12.1	Bu. 16.9	Bu. 21.9	Bu. 8.0	Bu. 23.9	Bu. 38.7	Bu. 21.4	Bu. 21.9	Bu. 15.3	Bu. 23.4	Bu. 18.6	Bu. 12.9	Bu. 15.4	Bu. 21.6	Bu. 16.3	Bu. 1,482	Bu. 1,253
	Spring plowed, corn topdressed	MCA 25.0	21.3	32.9	12.1	38.6	43.1	32.6	36.6	35.4	36.1	42.9	33.4	38.9	38.3	25.9	2,650	2,438
	Fall plowed	MCB 7.9	17.6	22.0	7.0	20.7	31.6	22.7	23.1	15.9	24.9	24.6	14.6	16.3	24.5	16.4	1,501	1,280
	Fall plowed and subsoiled	MCE 15.0	26.3	27.3	13.1	33.4	39.4	31.4	28.1	30.0	32.0	32.0	25.3	27.0	32.5	23.2	1,976	1,721
	Lister planted	MCF 14.3	20.9	28.6	6.7	31.1	31.4	26.7	31.1	26.7	26.4	25.7	21.6	22.9	25.7	18.9	1,528	1,376
	Early cultivated, lister planted	MCG 12.9	23.1	31.3	6.6	34.0	34.4	27.4	31.9	28.9	29.1	28.3	23.7	26.3	27.3	20.6	1,735	1,570
	Oats, spring plowed	142 3.0	12.4	21.7	2.4	21.7	37.6	21.4	25.4	16.3	19.4	25.4	19.3	17.1	17.2	14.9	1,807	1,660
	Sorgo, fall plowed	274 4.3	18.4	18.4	1.4	18.9	36.6	11.9	20.9	6.7	26.7	19.9	14.3	13.7	19.6	13.6	1,510	1,510
	Fallow	MCC-D 12.1	27.7	25.3	20.1	29.3	39.6	24.9	31.0	25.9	32.6	31.4	12.9	21.3	32.1	22.0	1,855	1,652

¹ There were no ear corn yields in 1917, 1918, or 1925. These years are represented in the averages.

